(2)

Active/Reserve Cost Methodology

Case Studies

Michael G. Shanley

RAND | NATIONAL DEFENSE RESEARCH INSTITUTE

The research described in this report was sponsored by the Assistant Secretary of Defense (Program Analysis and Evaluation) and by the Assistant Secretary of Defense (Force Management and Personnel). The research was conducted in the National Defense Research Institute, RAND's federally funded research and development center supported by the Office of the Secretary of Defense and the Joint Staff, Contract No. MDA903-90-C-0004.

Library of Congress Cataloging in Publication Data

Shanley, Michael G., 1947–
Active/reserve cost methodology : case studies / Michael G. Shanley.
p. cm.
"Prepared for the Assistant Secretary of Defense (Program Analysis and Evaluation) and the Assistant Secretary of Defense (Force Management and Personnel)."
"R-3748/2-PA&E/FMP."
ISBN 0-8330-1149-9
1. United States—Armed Forces—Organization—Mathematical models.
2. United States—Armed Forces—Reserves—Mathematical models.
3. United States—Armed Forces—Costs—Mathematical models.
I. RAND Corporation. II. Title.
UB23.S48 1991
355.3'0973'0151—dc20 91-18893
CIP

The RAND Publication Series: The Report is the principal publication documenting and transmitting RAND's major research findings and final research results. The RAND Note reports other outputs of sponsored research for general distribution. Publications of RAND do not necessarily reflect the opinions or policies of the sponsors of RAND research.

Published 1991 by RAND
1700 Main Street, P.O. Box 2138, Santa Monica, CA 90407-2138

R-3748/2-PA&E/FMP

Active/Reserve Cost Methodology

Case Studies

Michael G. Shanley

Prepared for the
Assistant Secretary of Defense
(Program Analysis and Evaluation)
Assistant Secretary of Defense
(Force Management and Personnel)

RAND

PREFACE

This report employs three case studies—one each in the Air Force, Army, and Navy—to demonstrate and extend a previously developed method for assessing the cost consequences of altering the mix of active and reserve units in the total force. The results should be of interest to those concerned with altering the mix of active and reserve units and especially to those who must estimate the costs of such alterations.

The underlying methodology used as a basis for this analysis was introduced in two other reports: Glenn A. Gotz, Michael G. Shanley, Robert A. Butler, and Barry Fishman, *Estimating the Costs of Changes in the Active/Reserve Balance,* R-3748-PA&E/FMP/JCS, September 1990, and John F. Schank, Susan Bodilly, and Michael G. Shanley, *Cost Element Handbook for Estimating Active and Reserve Costs*, R-3748/1-PA&E/FMP/JCS, September 1990. A fourth report in the series, *Guidelines for Planning the Cost Analysis of Force Structure Change* (R-4061-PA&E/FMP, forthcoming), will assist analysts who are estimating the cost of a force structure change in applying the principles of the methodology.

This research is part of a broader agenda of cost and resource analysis studies conducted within RAND's Defense Manpower Research Center. First, in developing the active/reserve cost methodology noted above, the authors drew upon previous research on active and reserve unit costs: John F. Schank, Susan J. Bodilly, and Richard Y. Pei, *Unit Cost Analysis: Annual Recurring Operating and Support Cost Methodology,* R-3210-RA, March 1986, and John Schank, Susan Bodilly, and Allen Barbour, *Cost Analysis of Reserve Force Change: Non-Recurring Costs and Secondary Cost Effects,* R-3492-RA, May 1987. Second, RAND is currently completing the "DoD Cost Factor Project," designed to provide a detailed view of the status of cost factors in each of the Services circa 1991. Reports from that project will be useful reference documents for all analysts concerned with costing defense functions and activities. Finally, RAND has just begun a major new project that will design, develop, and implement a force structure costing capability in the Office of the Assistant Secretary of Defense (Program Analysis and Evaluation).

This research was sponsored by the Office of the Assistant Secretary of Defense (Program Analysis and Evaluation) and the Office of the Assistant Secretary of Defense (Force Management and Personnel).

The Defense Manpower Research Center is part of RAND's National Defense Research Institute, a federally funded research and development center sponsored by the Office of the Secretary of Defense and the Joint Staff.

SUMMARY

During the programming and budgeting phases of the federal budgeting process, military analysts are sometimes asked to evaluate the cost consequences of changing the mix of active and reserve units in the total force. It is not uncommon for chronic problems to impede the analysis: proposed changes are vaguely defined, appropriate cost factors are difficult to obtain, insufficient time is available for a thorough analysis, and the Services and the Office of the Secretary of Defense (OSD) lack an agreed-upon and documented methodology.

To address some of those problems, RAND developed a systematic, structured accounting framework designed to assist the analyst in (1) translating typically worded force-mix proposals into fully specified cost problems, (2) calculating the full spectrum of costs implied by that specification, and (3) presenting the cost results in a context that describes changes in military capability. The method, which is suitable for automation,[1] centers on a procedure for documenting the resource, activity, and mission changes that follow from a force structure change.[2]

This report aims to validate and extend the active/reserve cost methodology, and to train analysts in its use. To accomplish those goals, the study analyzes the costs of three proposed force structure changes—one each from the Army, Navy, and Air Force. All three cases consider decisions that would alter the mix of active and reserve units in the total force. Collectively, the cases span a wide range of cost issues and problem circumstances and, in two of the three instances, are based on actual proposals that arose in the Planning, Programming, and Budgeting System (PPBS) process. (The report recommends no specific force structure decisions; the cases are designed to illustrate the strengths and proper use of the methodology.)

The report concludes that the active/reserve cost methodology will perform effectively in a wide variety of contexts. Also, to encourage further application, the report clarifies and extends the meaning of

---

[1]The issue of automation will be discussed in a forthcoming RAND report.

[2]Although summarized in this report, the methodology is more fully explained in two other RAND reports: Glenn A. Gotz, Michael G. Shanley, Robert A. Butler, and Barry Fishman, *Estimating the Costs of Changes in the Active/Reserve Balance*, R-3748-PA&E/FMP/JCS, September 1990, and John F. Schank, Susan Bodilly, and Michael G. Shanley, *Cost Element Handbook for Estimating Active and Reserve Costs*, R-3748/1-PA&E/FMP/JCS, September 1990.

critical concepts used in the methodology and shows how new issues might be addressed within its boundaries. Finally, the report outlines how the methodology might be extended in the future. Below, we more fully explore these conclusions and the case studies on which they are based.

THE CASE STUDIES

C-5 Case (Air Force)

During development of the FY88–92 budget, the Air Force offered the transfer of 26 C-5A cargo aircraft to the reserve forces as a cost reduction measure. However, a study group formed by the Deputy Secretary of Defense found that any significant savings could occur only after recouping substantial transition costs. We recast and supplement[3] the group's study in terms of the new force structure methodology.

Although a straightforward transfer of major equipment, the proposed changes in force structure were complex, offering a tough test of the new method's flexibility. The two major options would have affected force structure at five bases, and involved the creation of new units in the Air National Guard and Air Force Reserves, the reduction in existing C-5 active units, and an increase in existing C-5 reserve units. Although equipment in the total force would have remained constant, the net effect would have been to increase the total number but decrease the average size of C-5 squadrons.

A detailed analysis of the transfers showed that only small Operating & Support (O&S) savings were possible. Although the C-5 reserve units would use more part-time manning, the difference was not large and was partially offset by the increase in the total number of personnel under the two transfer options. Similarly, the decrease in operating tempo (OPTEMPO) under the proposed changes was relatively small, and it, too, was offset by other factors, including the loss of flying hours to support the C-5 airlift mission. In fact, total equipment operation costs (including the cost of commercial lift to replace lost military airlift) were higher under both transfer options than in the base case.

Transition costs under both the transfer options proved high when compared with the recurring savings. Those costs were especially large under the second option, which called for the establishment of a

[3]The supplementary information came from interviews with the Program Analysis and Evaluation (PA&E) analysts involved in the original study.

new C-5 base with high-cost facilities. Even under the first option, it would have taken 10 years to recoup the cost of transition from operational savings; but under the second option, that period was more than five times longer.

FF-1052 Case (Navy)

During a review of the FY90–91 budget under the Bush Administration, changing the mix of active and reserve units became a major budget issue for the Navy. One formal proposal involved the transfer of 24 Navy frigates to the reserve forces between fiscal years 1990 and 1993. The Program Budget Decision (PBD) that analyzed the proposed change estimated a potential savings of about $10 million during the transition period (1990–1994), and about $1 million annually per ship afterward.

Although official documentation of the Program Budget Decision was unavailable, we gathered enough information and data[4] to analyze a similar proposal using the new methodology, and, in addition, to consider a great many more options. The frigate transfer question proved an appropriate illustration and test of the active/reserve methodology because it demonstrated its function of ensuring consideration of *all* costs of force structure change, and because it addressed the complex issue of how to compare alternatives in which both cost and mission capability are variable.

We found that the projected savings from the frigate transfers depended greatly on assumptions concerning the details of implementation—for example, whether the new reserve ships could use existing pier space, whether reserve endstrength would increase to man the new ships, whether sufficient personnel could be recruited in the ships' home ports, whether the forward deployment responsibilities of transferring frigates would be absorbed by other active ships, and whether reserve depot maintenance policies would be brought into line with those in the active Navy. Payback periods among the study's seven options varied from less than one year to more than 17.

[4]The information we used was compiled from interviews within the multiple offices of OSD and the Navy that produced or participated in an analysis of the proposal. In addition, the study used information from the Navy Visibility and Management of Operating and Support Costs (VAMOSC) data base.

AH-64 Case (Army)

In 1985, the Army decided to introduce the AH-64 attack helicopter into the Army National Guard as part of its equipment modernization program. This was unprecedented not only because the Guard was receiving new equipment at the same time as the active Army, but also because the AH-64 was the Army's first high-technology aviation weapon system. We chose the Apache as a case study in order to test the active/reserve methodology on a new type of unit (an Army aviation battalion) and in a unique context (the introduction of a new weapon system to the reserves). In addition, the case offered an opportunity to test the methodology in the context of a different type of force structure change—unit modernization. We compared the modernization of the first Guard unit receiving the equipment (an AH-1 unit in North Carolina) with a similar modernization in the active force.[5]

Results of the cost analysis suggest little difference between placing the new AH-64s in the active Army and placing them in the Army National Guard; regardless of component, the increase in operating costs over an AH-1 unit were about the same. Transition costs, although incompletely estimated, appeared somewhat greater in the Guard case, primarily because the AH-64s represented a new mission. To begin operation, the Guard had to purchase additional electronic support equipment already available in the active Army, had to upgrade the scout helicopters for the new unit, and had to design a fielding plan for the AH-64s that ensured that the Guard personnel could be properly trained without compromising their civilian job responsibilities.

CONCLUSIONS

The three case studies examined in this report demonstrate the broad advantages of the active/reserve cost methodology. First, the methodology fosters full problem definition. By requiring analysts to determine the source and disposition of all unit missions and resources, the "balance sheet" format helps uncover all units affected by a proposed change. This proved to be particularly important in distinguishing between options in the FF-1052 case. Second, the methodology helps the analyst look beyond the units targeted for change to properly calculate the *net forcewide impact* of a decision.

[5]Information about the modernization in the Guard came from the Aviation Division of the Army National Guard Bureau, and the 1st Battalion, 130 Aviation Regiment, in North Carolina.

This was particularly important in the AH-64 modernization case, in which the number of personnel in targeted units increased, but forcewide, endstrength remained constant. Third, because its balance sheets show the details of calculations, the methodology fosters accuracy and proper documentation. This discipline was especially useful in analyzing the C-5 transfer, a complex case involving many units and bases, and the FF-1052 problem, which compared a large number of options with dramatically different capabilities.

The cases also demonstrate the methodology's ability to perform effectively in a wide variety of contexts. The studies cover the three major Services and many different types of force structure change—activation, deactivation, modernization, augmentation, and unit equipment reduction. The methodology successfully dealt with complex cases involving either a large number of units or a large number of alternatives. Further, solutions to the type of real-world problems that cost analysts inevitably have to deal with were easily incorporated within the framework of the methodology. For example, how can the effects of changes in force structure be distinguished from other cost-cutting measures? When should information about the variance of a cost estimate be highlighted in a study? These were issues in the FF-1052 case. How should the analyst handle unfunded force structure expenditures? How should joint costs be allocated when the base is uncertain? When is it incorrect to compare two alternatives' nonrecurring costs? These were issues that arose in the AH-64 case.

The case studies enhance the methodology in several ways: first, they clarify and extend the meaning of important terms (e.g., "mission," "other units," and "excess capacity"). Second, they address new methodological issues, such as modifying the cost-element structure to accommodate aviation units in the Army National Guard, capturing changes in support organizations, registering savings that flow from collocation of similar units, and reflecting change to individual units within a multiunit problem. Third, the report offers new methodological tools: a format for clarifying complex force structure changes and a one-page worksheet for planning a complete and well-defined cost analysis.

The flexibility and wide applicability of the active/reserve cost framework suggest that analysts ought to be able to apply it to new situations and complexities that they encounter in their work. Although this report cannot provide the judgment required to make those adjustments and extensions, the text has been written to serve as a primer for developing that judgment. Thus, to support analysts in

learning the methodology, the case write-ups carefully explain the reasoning behind each application and extension.

The case studies reveal areas in which the methodology itself might be improved. First, extending it to a fully dynamic system that accounts for costs year by year would help incorporate results into budget documents. For the same reason, existing cost-element categories could be mapped into budget and appropriation cost categories. Second, additional research into cost elements that the model now treats as fixed overhead would allow it to consider larger force structure changes. Third, automating the methodology—the subject of a forthcoming RAND report—would greatly facilitate the timely completion of cost studies. Fourth, further enhancements to reflect the differences between the individual Services would prove helpful. To this end, additional case studies, properly chosen, would increase the comprehensiveness of the methodology, although with diminishing returns.

Finally, the case studies highlight the need for enhancements to the cost factors that serve as input to force structure modeling, especially in nonrecurring transition costs. All three case studies strongly suggest that the relative difficulty of obtaining transition factors leads to imbalances in force structure decisionmaking, especially in budget-cutting drills. In those instances, proposed options typically compare potential operational savings with front-end transition costs. Clearly, knowing only half of the equation does not allow for optimum choice. Thus, in the C-5 case, the difficulty of calculating transition costs led to the detailed consideration of an alternative that should have been screened out at a much earlier stage. And in the FF-1052 case, an alternative was chosen based on the undocumented assumption that transition costs would be zero.

CONTENTS

TABLES

1. INTRODUCTION

During the programming and budgeting phases of the Planning, Programming, and Budgeting System (PPBS), cost analysts are sometimes called upon to evaluate the cost consequences of force structure changes that alter the mix of active and reserve units. The results of those analyses should be highly accurate. But a number of barriers stand in the way. Results may be needed quickly—within days or even hours. The proposed changes are often vaguely defined. Appropriate cost factors and other data may be difficult to obtain, especially in a short time. The complexity of the process is increased because the Services and the Office of the Secretary of Defense (OSD) lack an agreed-upon methodology for addressing changes in the force mix. Moreover, making the proper adjustments and extensions is not always within the expertise of the cost analysts assigned to the task.

To help overcome these barriers, RAND developed a systematized approach to force structure costing.[1] At the heart of the methodology is a procedure for documenting the resource, activity, and mission changes attendant to alterations in the active/reserve force mix, and a well-defined cost-element structure for capturing the full spectrum of costs.[2] To support that process, RAND also developed a set of guidelines to assist the analyst in translating simply worded force-mix questions into fully developed problem definitions. Finally, RAND has investigated the potential for automation of the procedure. These costing methods were designed to promote a timely response to costing problems while at the same time protecting against the improperly defined or incomplete cost analyses that can result from less rigorous approaches.

This report validates and extends the methodology by showing how the methodology could have been used in three force structure decisions. The case studies involve C-5 squadrons in the Air Force, FF-

[1]In addition, RAND undertook a separate project on the problem of obtaining cost factors that support force structure decisionmaking on a timely basis. The project dealt with the need and availability of appropriate cost factors for decisionmaking in the PPBS and weapons acquisitions processes.

[2]Those methodologies are explained in Glenn A. Gotz, Michael G. Shanley, Robert A. Butler, and Barry Fishman, *Estimating the Costs of Changes in the Active/Reserve Balance*, R-3748-PA&E/FMP/JCS, September 1990, and John F. Schank, Susan Bodilly, and Michael G. Shanley, *Cost Element Handbook for Estimating Active and Reserve Costs*, R-3748/1-PA&E/FMP/JCS, September 1990. A summary of those methodologies appears later in this section.

1052 class frigates in the Navy, and an AH-64 battalion in the Army. The cases were chosen because they span a wide range of cost issues and problem circumstances that can arise in the context of active/reserve force structure changes. Two (the C-5 and the FF-1052) are based on actual proposals that arose in the programming phase of the budgeting cycle to transfer missions from the active to reserve forces. The AH-64 case, not an issue in the PPBS process, represents an important class of active/reserve force structure changes—equipment modernizations—that have not previously been examined using the new methodology.

The report is designed to demonstrate the active/reserve cost methodology and to further understanding about how the methodology would operate under a variety of previously unexplored circumstances. In the process, the report strives to give cost analysts the ability to apply the methodology in their own work. To achieve these goals, more emphasis is placed on *how to* use the methodology and less on the case studies' outcomes themselves. (We make no recommendations regarding specific force structure decisions nor do we argue for the accuracy of final costs. Rather, we claim only that the assumptions concerning force structure change and costs are reasonable and suitable for illustrating the active/reserve force structure methodology.)

The remainder of this section summarizes the original methodology and describes the approach used in the case studies. For more information on the methodology, the reader should refer to the companion publications.

THE BASIC METHODOLOGY

We describe the methodology according to the four major stages of a cost analysis: problem definition, resource and mission analysis, cost calculation, and results.

Problem Definition

The analyst should begin by defining the scope and exact nature of the proposed force structure change, including all the alternatives that are to be considered. For each alternative, the definition identifies which units are targeted for change and what type of change is involved. Force structure changes can affect the total number of units (establishing new units, dissolving old ones) or their composition (replacing equipment, augmenting it, or changing personnel structure, such as the aircraft crew ratio). In practice, descriptions of force structure changes can leave even this most basic information

undetermined. For example, the decision to transfer a mission to the reserve forces could mean, on the active side, a reduction in the number of units (through deactivation) or a change in unit composition (through modernization or the reduction of unit equipment). On the reserve side, it could mean an increase in the number of units (through the creation of a new unit) or a change in unit composition (through modernization or the augmentation of unit equipment).

To clearly identify the problem, analysts should ask the following questions: What is a realistic alternative(s) for a change in the force structure? What would have occurred in the absence of the proposed change? How will the force structure change be implemented? What units will be affected, directly or indirectly? The first two questions establish a base case and alternative futures in general terms; the second two begin to uncover the important cost-driving factors. This process—discovering the details of implementation—continues in the next step.

Resource and Mission Analysis

To determine the cost consequences of each force structure change, one must examine the changes in the resource and activity levels that drive cost. What is the effect of the change on manning type and quantity? On equipment type and quantity? What will be the effect on the operating tempo (OPTEMPO) of major equipment? How will the change affect basing structure? Decisionmakers require the answers to these questions not only for the units directly involved in the proposed change, but also for those that are indirectly affected. Only in this way can they assess the net effect of changes on the Department of Defense (DoD).

These resource questions focus on inputs. To place them into context, decisionmakers also require knowledge about changes in outputs—in force capability. While not as easily measured, changes in outputs can be described by setting out the exact nature of the force structure change, by examining changes in wartime mission statements, and by determining the change in selected output measures, such as readiness ratings, crew ratios, and peacetime operating tempos.

Thus, constructing a complete summary of resource and mission changes is a systematic way to capture all the cost implications of a force structure change. Equally important, it provides a context for evaluating the results expressed in dollar figures, making transparent what is being saved or bought.

Cost Calculation

The next step is to specify a cost model for the decision, derived by applying the six cost-driving factors from the previous step (OPTEMPO, manning amount, manning type, equipment amount, equipment type, and basing) to 17 cost-element categories. The categories vary somewhat depending on Service and weapon system; for illustration, the Air Force list appears below. (See R-3748/1-PA&E/FMP/JCS for the complete list and definition of cost elements.)

Nonrecurring categories
- Personnel acquisition
- Personnel training
- Equipment procurement
- Military construction
- Other

Recurring categories
- Military pay and allowances
- Civilian pay and allowances
- Replacement acquisition and training
- Support-related costs
- Petroleum, oil, lubricants (POL)
- Training munitions
- Maintenance material
- Replenishment spares
- Depot maintenance
- Replacement support equipment
- Modifications
- Other

The formulas for calculating these cost elements will vary depending on the type of data available and on peculiarities in problem circumstances. Commonly used estimating equations, along with sources of data for using them, are provided in R-3748/1-PA&E/FMP/JCS.

Results

The final step is to add up the estimated costs or savings and present them in a series of summary tables. One principle of this methodology is that cost figures must be placed in context. Thus, the summary tables should include not only changes in dollar amounts but also changes in output, as measured by force structure, mission, and

peacetime function. (The methodology does not measure capability directly, but the latter categories do measure changes in capability *indicators*.)

RESOURCE AND MISSION ANALYSIS: A CLOSER LOOK

Although each of the case studies will include all four steps of the basic methodology, the second step—resource and mission analysis—will be covered in more detail. The other steps require less attention. The first, defining the force structure change and identifying alternatives, will receive greater elaboration in a forthcoming document. The third step, specifying a cost model and estimating costs, has already benefited from illustration in case studies.[3] And the fourth step, presenting results in context, is considerably less complicated.

The resource and mission analysis step calculates the net effect of the force structure change on DoD resources, missions, and functions. Two elements of that goal are especially important. First, the method provides for a systematic accounting of resource changes. It breaks a proposed decision into the units that are affected, then systematically documents the changes that occur in each unit so that a net effect can be calculated.

Second, the method helps identify all the units relevant to the cost analysis, including indirectly affected units that might otherwise be overlooked. The process accomplishes this by forcing the analyst to inquire about the source of all added resources and missions, and about the disposition of all subtracted resources and missions. For example, if the questioning determines that a newly established unit will draw personnel from other units, or that a deactivating unit will transfer part of its peacetime mission to other units, then those other, indirectly affected units can be added to the scope of the costing problem.

The following sections describe the method in some detail. Readers requiring more information should refer to R-3748-PA&E/FMP/JCS.

---

[3]R-3748/1-PA&E/FMP/JCS is a handbook of methods and information sources for estimating individual cost elements and factors after resource implications have been clarified. Case studies that focus on those methods and factors appear in two other RAND publications—*Unit Cost Analysis: Annual Recurring Operating and Support Cost Methodology*, J. F. Schank, S. J. Bodilly, R. Y. Pei, R-3210-RA, March 1986; and *Cost Analysis of Reserve Force Change: Nonrecurring Costs and Secondary Cost Effects*, J. F. Schank, S. J. Bodilly, A. A. Barbour, R-3492-RA, May 1987.

Categories of Unit Change

Units can be changed in five dimensions:

Wartime mission—the wartime activities the unit is to conduct and the unit's capability in performing those tasks. Mission can be indicated in a wide variety of ways, including by the type of unit change (e.g., modernization, augmentation, or disestablishment), by changes in readiness ratings or other direct measures of capability, or by changes in resource levels or other indirect measures of capability.

Peacetime function—the activities performed by the unit in peacetime, including unit functions performed both exclusively for the benefit of the unit itself (e.g., training) and those that serve, at least in part, other parts of the force (e.g., provision of lift services by cargo aircraft).

Manpower—the number and type of personnel in the unit. At a minimum, manpower listings should distinguish between active and reserve, full-time and part-time, military and civilian, and officer and enlisted. Other distinctions that could prove important include job classification, grade level, and years of service.

Equipment—the unit equipment inventory, including major weapon systems, ground support equipment (aviation units only), maintenance support and test equipment, training equipment, the initial stock of spare parts, and the initial unit munition requirements.

Basing—characteristics of the unit's location, including the facilities required to perform the mission and the land on which it is located.

The categories describe the unit from both an input and output point of view. Manpower, equipment, and basing are units of input; wartime mission is an output. Peacetime function is a measure of output, but when expressed as an OPTEMPO also measures the rate at which resources (inputs) are consumed (e.g., POL per flying hour). Meaningful analysis requires measures of both inputs and outputs so that costs and savings can not only be calculated but be placed in the context of capabilities.

The five unit change categories are interrelated. For example, when a unit's mission is changed, it will often require a corresponding change in personnel, equipment, and basing to make the unit capable of carrying out its new mission. These interrelations provide opportunities to cross-check changes in the different categories. For example, the analyst can ask whether a documented increase in unit mission is reflected by the allocation of additional manpower and

equipment. Such cross-checks help protect against inconsistent plans or plans based on dubious assumptions.

Transaction Categories

For each category of unit change, five types of transaction can occur. Basically, of course, resources can be added or subtracted. The methodology limits those terms to "target" units—those specifically targeted by the proposed decision. To account for additions and subtractions in other parts of the force, we use two additional transaction categories: "transfer from or to other units" and "transfer from or to idle capacity." The net effect can then be calculated in the last transaction category by summing the effects in the first four.

The distinction between "target" and "other" units is useful especially when it is not possible to specify exactly what parts of the force are affected by a force structure change. An example is when the personnel of a deactivated unit are reassigned throughout many units in the remaining force structure. The additional transaction categories also enable the analyst to calculate the net effect of a force structure change on the DoD, and, in particular, to recognize that not all resource changes in the target units represent resource changes to the DoD.

The five transaction categories are more formally defined below:

Resource addition to target unit: the addition of resources, activities, or missions to a target unit, whether by creating a new unit or changing one that already exists.

Resource subtraction from target unit: the subtraction of resources, activities, or missions from a target unit by disestablishing or altering existing units.

Transfer from or to other (nontarget) units: resources, activities, or missions added to, or subtracted from, indirectly affected units.

Transfer from or to excess capacity: equipment or real property added to or subtracted from the inventory of idle resources owned by the DoD.

Net change: the overall resources or activities added to or subtracted from the total DoD pool; that is, the "bottom line" of a resource transaction, calculated by adding up changes in the other four transaction categories.

Unit Transaction Balance Sheet

The unit transaction balance sheet forms the centerpiece of the accounting system. Table 1.1 shows the format of the balance sheet in high-level terms. Along the top of the matrix are the five transaction categories, ending with the net change calculation described above. In the left-hand column are the five dimensions of unit change: wartime mission, peacetime function, manpower, equipment, and basing. For each decision alternative, the analyst fills in a separate version of Table 1.1. For each dimension of unit change, multiple subelements are possible. The choice of these subelements, left largely to the analyst's discretion, can vary widely depending on the nature of the problem. For guidance in choosing subelements, analysts can refer to case studies such as this one. Table 1.2 provides one example, based on a hypothetical case. (This table was drawn from R-3748-PA&E/FMP/JCS and is further explained there.)

Table 1.1

Unit Transaction Balance Sheet: General Form

Type of Unit Trans-formation	Target Units: Addi-tions	Target Units: Sub-tractions	Transfer from/to Other Units	Transfer from/to Excess Capacity	Net Change
Wartime mission					
Peacetime function					
Manpower					
Equipment					
Basing					

CASE STUDIES

The next three sections present the case studies themselves. Each section covers one case, beginning with a brief description of the circumstances, a highlighting of the major conclusions concerning methodological issues, and finally a working through of the details of the cost analysis. The detailed portions of the cases are intended to instruct cost analysts in how to apply the methodology. The final sec-

tion is a summary description of how well the methodology worked in practice. Drawing on all three cases, it presents conclusions on the methodology itself: how well it performed, how the cases have extended it, and what directions seem most promising for future research.

Table 1.2

Summary Unit Transaction Balance Sheet: Example of Army Infantry Unit Transfer to Reserves

Type of Unit Transformation	Primary Units: Additions	Primary Units: Subtractions	Other Units: Transfer from/to Other Units	Other Units: Transfer from/to Idle Capacity	Net Change
Wartime mission					
Army reserve infantry unit	+				+
Army infantry unit		–			–
Antitank role		–			–
Reconnaissance role	+				+
Function					
Field training	5 hr/wk	–30 hr/wk			–25 hr/wk
Post guard duty		–240 hr/wk	80 hr/wk		–160 hr/wk
Recruiting duty	16 hr/wk				16 hr/wk
Manpower					
Active					
Officer		–9	9		0
Enlisted		–243	243		0
Reserve					
Officer	9				9
Enlisted	212				212
Civilian	12				12
Equipment					
Light vehicles	50	–20			30
Rifles	20	–4			16
Recon units	40				40
TOW missiles	10	–160	80	70	0
Basing					
Barracks construction		–40K sq ft		40K sq ft	0
Office construction	5K sq ft				5K sq ft

2. THE AIR FORCE C-5 STUDY

OVERVIEW

In the summer of 1986, during development of the FY88–92 program, the Air Force proposed transferring C-5A cargo aircraft to the reserves. A major purpose of the proposal was to reduce costs; in fact, the move was offered to offset increases in the Air Force program elsewhere. However, agreement could not be reached on the amount of the savings that such transfers might produce. For that reason, the Deputy Secretary of Defense initiated a study to determine the potential cost savings and readiness improvements. The Office of the Assistant Secretary of Defense (ASD), Program Analysis and Evaluation (PA&E), chaired the study group, which also included the Air Force, ASD (Comptroller), and ASD (Reserve Affairs). Although initial examinations had forecast substantial immediate savings, the study group concluded that the savings would be considerably smaller than initially forecast; that savings were possible only in the long run, after recouping the significant nonrecurring costs of making the transfer; and that the existence of any savings depended on a number of somewhat uncertain assumptions. In the end, the idea of the transfer was abandoned.

The "C-5 Study" case was chosen for this report for two reasons. First, because of the relatively large number of units involved and the complexity of the proposed force structure changes, the case offered a useful test of the new methodology. Second, an existing detailed study[1] would provide an opportunity to highlight differences and advances in the new methodology.

CASE STUDY CONCLUSIONS

The C-5 case demonstrates several important aspects of using the new methodology:

Define the base case: Analysts must establish force structure implications for not only alternative force structure changes but also for the base case, defined as the force structure that would exist in the absence of the proposed changes. If some decisions regarding force

[1]The study is a draft of the final report of the study group (no final report was formally issued) as it appeared in an attachment of a May 5, 1988, memo from the PA&E director's office to the ASD (Force Management and Personnel).

structure have already been made and their costs can be considered sunk, then the base case will differ from the current case.

Assess transition costs: Nonrecurring costs incurred during the transition period proved to be the major cost driver in the C-5 case and were largely responsible for the decision to not go ahead with the transfers. Analysts begin their assessment of these costs using the resource information on the equipment, basing, and manpower balance sheets.

Work at various levels of aggregation: When addressing multiunit problems, analysts often examine changes one unit at a time. Starting with the smallest unit avoids confusion, provides needed documentation, and helps ensure that no changes are inadvertently ignored. However, analysis involving an aggregation of units is sometimes more logical (e.g., when missions span more than one unit), and is especially useful when presenting results.

Construct special tables to describe complex force structure changes: When force structure alterations become complex, an initial understanding of the exact nature of the change (and of the likely cost consequences) can be gained from specially designed force structure tables. In the C-5 case, such tables not only clarified the alternatives, but also helped describe changes to wartime mission and highlighted significant cost-driving factors.

Define "target units" depending on the level of analysis: This methodology designates units as either "target" or "other." But in dealing with multiunit problems, the definitions change with the level of aggregation. Thus, units that are "target" units for purposes of the entire problem can become "other" units when examining a portion of the problem.

Choose appropriate categories to describe unit change: Analysts must choose which resources or functions to list separately on balance sheets. Most important, elements with significantly different prices must be listed separately. But even when prices are identical, clarity can sometimes require separate categories.

Use basing and equipment balance sheets to capture scale economies: The savings realized by collocating similar units can be captured using the balance sheet methodology. The procedure used requires an expansion of the term "excess capacity" as used in this context.

DETAILED ANALYSIS

Below is the detailed analysis supporting the conclusions above and documenting how the active/reserve force structure methodology works.

PROBLEM DEFINITION

In the initial configuration of the C-5 fleet, consisting of 66 C-5As and 44 C-5Bs, the aircraft resided at five bases in seven squadrons, ranging in size from 11 to 18 primary authorized aircraft (PAA). Table 2.1 shows the basing of the C-5 aircraft at the time of the study. Three of the seven units already resided in the reserves as the result of past transfers from the active component, leaving a maximum of 26 aircraft that could be transferred to the reserves. In addition, reservists were already serving in active squadrons as "Reserve Associates," a Air Force program whereby the reserves augment an active unit with aircrews and maintenance personnel.

But simply knowing that aircraft are to be transferred to the reserves is not enough. There are many ways of transferring major equipment, leading to a wide range of associated costs. Before meaningful costing can begin, two questions must first be answered. What would happen if the C-5s were not moved to the reserves? If a move to the reserves is decided, exactly how would force structure be changed? The first answer provides a base case, a benchmark against which alternatives can be compared. The second establishes an important (though preliminary) cost-driving factor in the analysis.

Table 2.1

Baseline C-5 Locations

	Travis A/RA	Dover A/RA	Kelly AFR	Westover AFR	Stewart ANG	Total
PAA						
C-5A	13	13	15	14	11	66
C-5B	22	22	0	0	0	44
Squadrons	2	2	1	1	1	7

NOTE: A/RA = Active/Reserve Associate; AFR = Air Force Reserve; ANG = Air National Guard.

Base Case

How the base case—the alternative to the proposed change—is defined can profoundly affect the analysis and determine the final decision. The basic alternative to the C-5 transfers to the reserves was, in fact, to leave the aircraft in their active units. Using that as a base, the transfers would entail an initial outlay of money (to cover transition costs) that would eventually be recouped by reserve operation of the aircraft. Whether the initial cost was sufficiently small, the long-term savings sufficiently large, and the payback period sufficiently short to warrant the transfers were, of course, the subject of the C-5 study. However, suppose the base case had been different; for example, suppose the transfers had been proposed to make room in the active basing structure for a new aircraft?[2] With that base case, the transfers would save money even at the outset, because they would reduce the unavoidable cost of basing the new aircraft.

As it happened, the C-5 base case did involve a change from the status quo: the crew ratio of reserve squadrons would increase from 2 to 3, and that of active squadrons would decrease from 3.6 to 3. This implied changes in costs (e.g., the shift of crews to the reserves would mean fewer flying hours and consequently reduced cost for equipment usage), but because those costs would accrue whether or not the transfer took place, they were considered "sunk" for purposes of the costing exercise and outside the scope of the problem definition.

Force Structure Changes

Once the base case has been established, the analyst must consider how the change would affect the force structure. The mere fact of the transfers does not provide any definitive answers in itself. The C-5 transfers could expand the total force structure, cause it to contract, or leave it unchanged. For example, the force structure would remain unchanged if the move required the deactivation of one or more active units and the establishment of the same number of reserve units. In contrast, the force structure would contract if the active units were eliminated but new reserve units were not created, as could occur if the transferred C-5s were used to modernize existing reserve units and if the existing equipment of those reserve units were then retired. Finally, the force structure would expand if the transferred equip-

[2]Such a scenario is not unrealistic. For example, if C-5 transfers were proposed in the mid-1990s, the move might be contemplated as a way to make room for the new C-17s coming off of production without having to expand the active base structure.

ment were used in new reserve units, and if the losing active units received new equipment (e.g., new C-5Bs from production).

According to the transfer plan actually proposed, the force structure would, in fact, expand, but not because of the introduction of new equipment. Rather, the number of squadrons was scheduled to increase because the existing C-5 aircraft were to be organized into a larger number of smaller units. This had important implications for cost because a greater number of smaller squadrons is usually more expensive to operate than a smaller number of larger squadrons due to the overhead costs associated with each squadron.[3]

Table 2.2 shows the before and after implications of the move in terms of squadrons and PAA for the two major options. Under the first option, all 26 C-5s would go to the Air Force Reserve; under the second, they would be split between the AFR and the Air National Guard. In both cases, however, the number of squadrons would increase; the active Air Force decided that despite their loss of inventory and squadron size, it would prefer to maintain the four existing Active/Reserve Associate C-5 squadrons (two at Travis and two at Dover) rather than merge them into two squadrons. Squadrons of 11 PAA were judged to be more manageable than squadrons of 22. Similarly, the Air Force Reserve and Air National Guard decided to organize their newly acquired equipment into small and moderately sized squadrons with as few as nine PAA each.

Table 2.2

Alternative Allocations of C-5 Aircraft: C-5 Study

	Number of Squadrons			Number of Aircraft (PAA)		
Component	Baseline	Option 1	Option 2	Baseline	Option 1	Option 2
Air Force	4	4	4	70	44	44
Air Force Reserve	2	6	3	29	55	43
Air National Guard	1	1	2	11	11	23
Total	7	11	9	110	110	110

[3]Each C-5 squadron requires at a minimum two or three overhead positions for squadron management. In addition, new squadrons produce overhead requirements at the wing and higher organizational levels. Moreover, a greater number of squadrons lead to higher equipment costs, as units' flying hour programs must be expanded to train the pilots in overhead positions. Finally, a greater number of squadrons may add to the nonrecurring costs of equipment and facilities construction.

Table 2.3 shows how the force structure changes were to be accomplished. The "Type of Change" column indicates that the changes would occur by activating new units and augmenting existing ones; the "Squadron Changes" column shows where new units would be created. The table also shows basing arrangements. Under the first option, all of the transferred aircraft would operate from airfields where C-5s are currently based. Under the second option, a squadron would be established at Memphis, a commercial airfield that has not previously supported C-5 operation. As will be shown later, taking advantage of the additional capacity at existing bases can greatly reduce the transition costs of the transfer (see further discussion under "Equipment and Basing" later in this section).

RESOURCE AND MISSION ANALYSIS

We next show the resource and mission changes implied by the two C-5 case study options, using the unit transaction balance sheet methodology.[4] All changes in the balance sheets are shown relative to the base case of not transferring the aircraft.

Wartime Mission

Table 2.4 summarizes the change in overall wartime mission as measured by the number of C-5 aircraft and crews. At the DoD level, no changes occurred; the same number of PAA existed before and after the change, and the mission requirement of 330 mission-ready crews was maintained. Under each option, the table shows that 78 crews (three for each aircraft) were subtracted from the active Air Force, but equivalent crews were added to the reserve components.

Although the C-5 fleet mission description would not change with the transfer, some might question whether the shift to reserve components and smaller squadrons would affect mission capability or readiness. Our methodology does not attempt to answer those questions. Rather, the goal is to clarify and report such changes along with changes in cost, thus giving decisionmakers the opportunity to evaluate capability issues when examining cost consequences.

[4]This methodology is briefly discussed in Sec. 1 of this report and in more detail in R-3748-PA&E/FMP/JCS.

Table 2.3

Change in Force Structure: C-5 Study

Component	Unit Location	Existing C-5 Base	Type of Change	Squadron Changes	Equipment Addition Item	Equipment Addition Source	Equipment Subtraction Item	Equipment Subtraction Destination
				Option 1				
Active	Travis, Dover	Yes	Equipment reduction	0	—	—	–26 C-5A	Travis (AFR) Kelly (AFR) Westover (AFR)
AFR	Travis	Yes	Activation	+2	19 C-5A	Active	—	
AFR	Kelly	Yes	Augmentation, split	+1	3 C-5A	Active	—	—
AFR	Westover	Yes	Augmentation, split	+1	4 C-5A	Active	—	—
				Option 2				
Active	Travis, Dover	Yes	Equipment reduction	0	—	—	–26 C-5A	Travis (AFR) Memphis (ANG)
AFR	Travis	Yes	Activation	+1	14 C-5A	Active	—	—
ANG	Memphis	No	Activation	+1	12 C-5A	Active	—	—

Table 2.4

Change[a] in Mission: C-5 Study

C-5 Mission	Target Units: Additions	Target Units: Subtractions	Transfer from/to Other Units	Net Change
		Option 1		
Number of crews				
Air Force		–78	78	0
Air Force Reserve	78		–78	0
		Option 2		
Number of crews				
Air Force		–78	78	0
Air Force Reserve	42		–42	0
Air National Guard	36		–36	0

[a]Options compared with the baseline case of not transferring the aircraft.

Peacetime Function

In peacetime, C-5 squadrons complete unit training, including training for staff overhead positions. As a by-product of those activities, they also provide peacetime airlift to other parts of the military. For costing purposes, these functions can be measured in terms of the unit's operating tempo (OPTEMPO), or flying-hour program.

Transferring the 26 C-5s to the reserve forces carries with it a potential reduction in peacetime flying hours because reserve aircrews are programmed to fly only about 80 percent of the training hours flown by their active counterparts.[5] Fewer flying hours translate into savings in operating and support costs.

The potential reduction in flying hours is, however, offset in this case by three factors. First, under the "Associate" concept in the Air Force, half of the aircrews in the active units are already in the reserve forces, flying at the reduced OPTEMPO. Second, both case study options specify an increased number of squadrons, an effect that increases the flying hour requirements for training in overhead positions. Finally, because a smaller proportion of reserve flying hours can be used to meet the C-5 peacetime airlift mission,[6] the transfer

[5]Some would attribute the reduced training schedule in C-5 reserve units to the more experienced reserve pilots, who maintain required skills with fewer flying hours than their active counterparts. Others would attribute the higher requirements of active crews to their requirement to fly longer overseas missions, undertaken partially to accomplish the peacetime airlift mission.

[6]Reserve flight training tends to focus more on local flying.

requires the purchase of civilian airlift to maintain the airlift mission of the C-5s.

Accounting for all three factors, transferring the 26 C-5s to the reserves would actually increase total flying hours, as shown in Table 2.5. Under Option 1, the flying hour program for unit training in active units would decrease by 11,310 hours, whereas the reserve unit flying hour programs would increase by 10,452 hours, a net of 858 hours less. That decrease is diminished, however, by a 412 flying hour increase for training in overhead positions. Finally, the decrease is erased completely by the required purchase of an estimated 1552 additional flying hours[7] from commercial carriers to maintain the airlift mission.[8] The net result is an increase in the total (of military and civilian) flying hours by 1106 (1552 − 446). The consequences of Option 2 are nearly identical.

Three aspects of Table 2.5 demonstrate the usefulness and flexibility of the balance sheet methodology. First, unit characteristics can be listed at higher levels of aggregation. Here, the peacetime mission is listed at the level of the entire C-5 fleet. That aggregation of units is justified because the airlift mission of C-5s is programmed at the level of the entire fleet.[9]

Second, because the choice of items in the left-hand column is left to the discretion of the analyst, the balance sheets can highlight important tradeoffs. Table 2.5 distinguishes overhead training from other unit training, even though that would not be required simply to com-

[7]The estimate assumes that 60 percent of the training hours in active squadrons but only 40 percent in reserve and Guard squadrons would generate by-product airlift. In the course of the case study, analysts agreed on the estimate for active squadrons but disagreed on the estimate for the reserves. The Air Force maintained that the number was closer to 30 percent, whereas Reserve Affairs maintained that the number was closer to 50 percent. For this study, the 40 percent figure was a result of splitting the difference.

[8]Calculating airlift requirements is a good example of how problem definition may have to expand in certain areas. The airlift mission of the C-5 is the same for the entire C-5 fleet. Thus, all C-5 aircraft must be considered in the calculation, regardless of whether the force structure change directly affects them.

[9]However, when first addressing the resource and mission changes caused by the force structure change, analysts would typically begin compiling worksheets at the lowest level of detail, the squadron in this case. Those worksheets would then provide back-up explanation for the summary table, and could be used to design new options or alter the parameters of existing ones.

Table 2.5

Change[a] in Peacetime Function: C-5 Study (In flying hours)

Type of Function	Target Units Additions	Target Units Subtractions	Transfer from/to Other Units	Net Change
		Option 1		
Unit training	10452	−11310		−858
Overhead training	1665	−1253		412
(By-product airlift)[b]	(4847)	(−6399)		(−1552)
Commercial airlift			1552	1552
		Option 2		
Unit training	10668	−11310		−642
Overhead training	1496	−1253		243
(By-product airlift)[b]	(4866)	(−6399)		(−1533)
Commercial airlift			1533	1533

[a]Options compared with the baseline case of not transferring the aircraft.
[b]Flying hours in parentheses are a subset of other functions' flying hours.

pute operating and support (O&S) costs. The distinction clarifies the conflicting effects of reduced unit training on the one hand, and increased training for overhead positions on the other. Separating effects that move in opposite directions makes it easier to understand the net implications of a change. Likewise, commercial airlift is included in the table, even though it is not technically a peacetime function of a military unit.[10] The purpose here is to show that the peacetime mission of the C-5s has been maintained (albeit by alternative means), and to clarify the fact that the change would lead to an increase in total flying hours.

Finally, the balance sheet format provides a built-in accountability system for the resource and mission analysis. By forcing analysts to record all peacetime functions in the context of force structure changes and to ask whether changes in target units are offset by changes in indirectly affected units, balance sheets encourage the def-

[10]The information is listed under the "Transfer" column because commercial carriers that provide the lift more closely resemble "other" units than "target" units in the context of the balance sheet methodology. Further, the number could not be included in the "By-product airlift" row because the cost-per-flying-hour of military and commercial airlift differs, and therefore those flying hours could not be combined in addition or subtraction operations. In general, resources or functions with differing associated prices require separate listings.

inition of a proper problem scope and the proper computation of "net" resource effects. A more conventional representation of flying hour changes, like that shown in Table 2.6, is sufficient for costing purposes, but does not provide the safeguards of listing all peacetime missions and of inquiring about offsetting effects.

Table 2.7 illustrates how the function balance sheet could, if required, work at another level of aggregation—in this case at the more detailed level of military components (active, reserve, or Guard). As mentioned above, lower levels of aggregation provide more detailed information and are the building blocks of aggregate tables and alternative option designs. For example, Table 2.7 shows that the decrease in unit training and by-product airlift would occur in the active Air Force, whereas the increase in overhead training would take place in the Air Force Reserve.

Table 2.7 also illustrates an important point about the distinction between "target" and "other" units in the balance sheet methodology. Note the use of the "Transfer from/to Other Units" in the first two rows. Row 1 says that of the 11,310 unit training flying hours in the active Air Force, 10,452 were "transferred to other units," leaving a net loss of 858. Row 2 says that of the 10,452 unit training flying hours gained in the reserves, all were "transferred from other units," leaving no net increase. In both cases, the "other" units are "target units" for purposes of the entire problem, but "other units" for purposes of the subset of units considered in the particular row. In general, therefore, the definition of "target" and "other" units depends on the level of aggregation.

Manning

Transferring missions to the reserve forces often carries with it a potential for manpower savings because of the use of part-time (instead of full-time) personnel. That potential was, however, significantly reduced in the C-5 case by three factors. First, under the "Associate" concept in the Air Force, half of the aircrew positions (and some of the maintenance positions) in the C-5 active units had already been converted to part-time, reducing the potential for further savings. Second, savings were reduced because C-5 units in the reserves have more programmed personnel positions than do similar active units. In the case of the C-5, a reserve unit with 14 PAA is programmed with about the same number of personnel as an Active/Reserve Associate unit with 18 PAA. Third, the C-5 requires that a relatively

Table 2.6

Flying Hour Summary: C-5 Study

	Unit Training			Overhead			Grand
Component	C-SA	C-5B	Total	Squadron	Other	Total	Total
			Baseline				
Active	6084	10296		1872	2119[a]		20371
RA	5226	8884		1120	1268[a]		16458
AFR	11658	0		666	666		12990
ANG	4620	0		210	620		5450
Total	27588	19140	46728	3868	4673	8541	55269
			Option 1				
Active	0	10296		1872	1335		13503
RA	0	8844		1120	799		10763
AFR	22110	0		1998	999		25107
ANG	4620	0		210	620		5450
Total	26730	19140	45870	5200	3753	8953	54823
			Option 2				
Active	0	10296		1872	1335		13503
RA	0	8844		1120	799		10763
AFR	17286	0		999	999		19284
ANG	9660	0		420	1240		11320
Total	26946	19140	46086	4411	4373	8784	54870

[a]Spread using squadron overhead.

large proportion (50 percent) of the personnel in the reserve and Guard work on full-time status, as either technicians (members of the unit who also have full-time civilian jobs maintaining the unit's equipment), full-time civilians in the active force, or full-time members of the Guard.

Table 2.8 shows the calculation of the net manning implications of the C-5 transfers.[11] On balance, the active and civilian categories decrease, whereas the reserve and Guard categories (including full-time technicians) increase. The net effect in most categories emerges from countervailing trends. For example, although the reserve categories have a net increase, they also have a negative component because the losing active units, as "Associate units," contain reserve personnel.

[11]As with the peacetime mission, the manpower tables have been printed in aggregate form, considering all targeted units as a group. When beginning the study, however, the analyst would prepare a manpower balance sheet for each unit affected.

Table 2.7

Change[a] in Peacetime Function by Component in Option 1: C-5 Study (In flying hours)

Type of Function and Component	Target Units Additions	Target Units Subtractions	Transfer from/to Other Units	Net Change
		Option 1		
Unit training				
Air Force		−11310	10452	−858
Air Force Reserve	10452		−10452	0
Overhead training				
Air Force		−1253	1253	0
Air Force Reserve	1665		−1253	412
By-product airlift				
Air Force		−6399	4847	−1552
Air Force Reserve	4847		−4847	0
Commercial	1552			1552

[a]Option compared with the baseline case of not transferring the aircraft.

Similarly, although the active categories show net decreases, they also have a positive component because enlisted active personnel are used in the reserve units. This detailed information is important both as documentation for the calculation of the net effects on manning, but also as input to the calculation of transition costs (e.g., training and severance costs).

The manpower balance sheet also communicates information about endstrength policy. The column of zeroes under "Transfer from/to Other Units" in Table 2.8 indicates that the net changes in target units were to be reflected in the total force; that is, that endstrength levels in the active Air Force were to decrease by the amounts shown for the target units, whereas levels in the Air Force Reserve and Air National Guard were to increase by the amounts shown.

The reduction in active endstrength does not, however, mean that personnel in the losing units were themselves to leave the force. More likely, they would simply be reassigned to other units, while personnel would decrease somewhere else in the force. This is illustrated in Table 2.9, which shows manpower implications at a lower level of aggregation—for Travis Air Force Base under Option 1. Here, the "Transfer from/to Other Units" column shows not only that the active personnel from losing units were to be reassigned to other

units,[12] but also that some of the reserve personnel from gaining units were to come from the reserve forces.

The left-hand column entries in both Table 2.8 and 2.9 illustrate the principle of distinguishing resource groupings based on their cost differential. The tables distinguish officer from enlisted personnel and part-time from full-time personnel because the average pay between

Table 2.8

Change[a] in Manpower: C-5 Study

Type of Manpower	Target Units		Transfer from/to	Net
	Additions	Subtractions	Other Units	Change
		Option 1		
Active				
Officer		−144	0	−144
Enlisted	130	−1914	0	−1784
Reserve				
Officer	294	−108	0	141
Enlisted	2901	−1022	0	1879
Air Reserve Technician			0	
(ART)	1526	−276	0	1250
Civilians	91	−214	0	−123
		Option 2		
Active				
Officer		−144	0	−144
Enlisted	86	−1914	0	−1828
Reserve				
Officer	155	−108	0	47
Enlisted	1644	−1022	0	622
Guard—part time				
Officer	138		0	138
Enlisted	1419		0	1419
Guard—full time				
Officer	19		0	19
Enlisted	161		0	161
ART	945	−276	0	669
Air Technicians (AT)	550		0	550
Civilian	59	−214	0	−155

[a]Options compared with the baseline case of not transferring the aircraft.

[12]In fact, some would be reassigned to the gaining reserve units at Travis Air Force Base. Even though those reserve units were "target units" for the larger problem, the upper part of Table 2.11 treats them as "other units" in this active unit tabulation. The definition of target and other units is further discussed above, under "peacetime function."

Table 2.9

Change[a] in Manpower Originating at Travis Air Force Base Under Option 1: C-5 Study

Type of Manpower by Unit	Target Units Additions	Target Units Subtractions	Transfer from/to Other Units	Net Change
C-5 active units at Travis				
Active personnel				
Officer		–72	72	0
Enlisted		–957	957	0
Reserve personnel				
Officer		–54	54	0
Enlisted		–511	511	0
Air Reserve Technician		–138	138	
Civilian		–107	61	–46
C-5 reserve unit at Travis				
Active personnel				
Enlisted	111		–111	0
Reserve personnel				
Officer	193		–54	139
Enlisted	2153		–511	1642
Air Reserve Technician	907		–138	769
Civilian	61		–61	0
Other units				
Active personnel				
Officer			–72	–72
Enlisted			–846	–846

[a]Options compared with the baseline case of not transferring the aircraft.

those categories differs more than the average pay within categories. Embodied within the choice of those categories is the assumption that average cost factors for those groups (e.g., officer personnel and enlisted personnel) were close enough to actual pay averages within the C-5 units that the chosen categories would suffice. For other force change proposals, more detail might be required. For example, suppose that the proposal had been to cut accessions in particular rather than active endstrength in general. In that case, the analyst would need to distinguish active personnel by grade or average years of service.

Equipment and Basing

The C-5 study group report listed the following as nonrecurring equipment and basing costs.[13] Under Option 1, creation of a new reserve unit at Travis, an existing C-5 active base, would require construction of $20 million worth of operational and maintenance facilities. Under Option 2, the same facilities would require construction at Travis plus construction of facilities for the new Guard unit at Memphis Naval Air Station (NAS), an independent ANG location that had previously supported C-130B operations. The Memphis NAS would require $142.2 million for runways, operational and logistics facilities, and aircraft hangers. In addition, that unit would require $21.2 million for support equipment, and $7.1 million for initial spares. These figures were provided by the Air Force and the reserve components and reflect cost estimates made at the sites.

The problem with a simple listing of transition cost dollar amounts is that they give decisionmakers no benchmark for comparison. Information about equipment and basing costs would be much more useful if it could be presented in the context of requirements. For example, in the C-5 case decisionmakers would benefit from knowing that Option 1 involved a large savings in equipment and facilities costs because excess capacity was used on existing C-5 bases.

The unit transaction balance sheet allows incorporation of information on requirements that can capture scale economies. Table 2.10 shows the details for the C-5 case. All the information on nonrecurring equipment and construction cost estimates,[14] as described above, is captured in the "Net Change" column to the far right. The rest of the table contains useful supplemental information. The full cost of the equipment and facilities for a typical new C-5 squadron is contained in the "Additions" column, and represents equipment and basing cost factors[15] for C-5 squadrons. The fact that the cost factors

[13]Equipment and basing are considered together because they both concern transition costs and because we were not able to obtain enough detailed information to warrant separate treatment.

[14]Because more conventional measures of resources are unavailable, Table 2.10 had to use dollars as the unit of account. If the information had been available, the table's resource amounts would have been expressed in more conventional units of analysis, such as counts of different types of equipment (perhaps using Air Force Tables of Allowances for the units involved) and lists of square footage associated with different types of facilities. In essence, the table uses cost factors to replace resource factors, thereby bypassing the usual step of multiplying resource factors by cost factors to calculate total costs.

[15]In the absence of readily available cost factors for equipment and basing, we created some of our own to illustrate their usefulness. In particular, we assumed that

are larger than the actual estimated costs indicates that the transfers were designed to take advantage of existing facilities and inventories. How much was saved by collocation is indicated in the "excess capacity" column. In Option 1, nearly the entire requirement is avoided, whereas in Option 2, which calls for a new independent C-5 base, a significant proportion of the full requirement must be paid.

Table 2.10's construction of represents an expansion of the term "excess capacity" as used in the balance sheet methodology. Until now this term has referred to changes in resource counts, such as the number of support equipment packages, the volume of training muni-

Table 2.10

Change[a] in Equipment and Basing: C-5 Study

Type of Unit Transformation	Target Units Additions	Target Units Subtractions	Transfer from/to Other Units	Transfer from/to Excess Capacity	Net Change
			Option 1		
C-5As (number)	26	–26			0
Support equipment and initial spares ($M)	28.3[b]			–28.3[c]	0
Facilities ($M)	142.2[b]			–122.2[c]	20
			Option 2		
C-5As (number)	26	–26			0
Support equipment and initial spares ($M)	56.6[d]			–28.3[c]	28.3
Facilities ($M)	284.4[d]			–122.2[c]	162.2

[a]Options compared with the baseline case of not transferring the aircraft.
[b]Requirement for standard C-5 squadron.
[c]Savings due to collocation of squadron on a C-5 base.
[d]Requirement for two standard C-5 squadrons.

support equipment and initial spares would cost $28.3 million per C-5 squadron, and facilities $142.2 million per stand-alone C-5 squadron. Those were the site specific amounts estimated for the new squadron at Memphis, a base with no existing C-5 facilities. For squadrons collocating with other units on an existing C-5 base, we assumed a zero cost for support equipment and spares, and $20 million for facilities. Those were the site specific amounts estimated for the new reserve unit at Travis. We make no claims on the accuracy of these as general factors, only that they are appropriate to illustrate the methodology we are exploring.

tions, or the acreage of land. As used above, however, the term refers to the unused capacity of a given resource. Thus, if a decision to collocate units translates into savings in facilities costs when compared with the costs for a stand-alone unit, the decision is considered to have tapped the "excess capacity" of existing facilities.

A current problem with the construction of tables like the one above is the lack of standard factors for equipment and basing that relate cost to units of output (e.g., the cost of support equipment per C-5 squadron). In fact, even Table 2.10 used stand-in cost factors, listed for illustration only. The creation and publication of more nonrecurring cost factors could correct the current deficiencies in the calculation of nonrecurring costs. The fact that those amounts can vary considerably on a case-by-case basis means only that more than one set of factors would be useful. For example, basing cost factors might be estimated for both stand-alone and collocated units.[16]

Analysts and decisionmakers would gain several advantages by having nonrecurring cost factors (as opposed to only site specific total dollar estimates) to use in the context of the balance sheet methodology. First, estimates of transition costs would be available early in the decision process, in time to compare with early estimates of recurring cost savings. In this way, low potential transfer options (like Option 2 in the C-5 case) could more easily be screened out early in the process.[17] Second, the estimates would add a perspective about the quality of the options that would otherwise be absent; for example, that Option 1 represents a near-optimal use of existing resources. Third, the information would provide the tools and incentive for the discovery of other options. For example, the large expense of establishing stand-alone C-5 units might suggest the abandonment of Option 2 in favor of a search for another option that uses all C-5 bases.

[16]In the absence of useful cost factors, lists of case histories would prove useful. For example, at the time of the C-5 study, other transfers of C-5s to the reserves had just been completed. An itemized list of the transition costs in those moves would have been useful.

[17]Lists of site specific costs often arrive too late in the decision process to affect initial choices about which force structure changes to consider in detail. For example, the C-5 case was first proposed because of the potential for recurring cost savings, calculations that readily available data would support. It was only later, after the C-5 study group was formed and a site specific analysis was completed, that it was determined that the transition costs would be high.

COST CONSEQUENCES AND RESULTS

The C-5 transfer costs can be calculated by mapping the information on the balance sheets constructed above into a comprehensive cost-element structure. The procedure calls for multiplying the "net changes" calculated in the resource and activity analysis (e.g., part-time reserve Air Force officers) by appropriate cost factors (e.g., the cost per officer). The modeling procedure is well explained in the source documents for this report (R-3748-PA&E/FMP/JCS and R-3748-1-PA&E/FMP/JCS) and the cost factors are provided in the C-5 study group report, so we proceed directly to the final results.

The full cost results are shown in Table 2.11. The costs of the baseline program, including the operation of C-5Bs (totaling $779 million), appear in the first column; the other two columns show the incremental costs of the two alternatives relative to the baseline. Included are both the nonrecurring transition costs and the recurring costs once the steady-state has been reached. The recurring equipment costs have been aggregated according to cost driver, on a per flying hour and per aircraft basis.

Table 2.11

Cost Comparison: C-5 Study (In $ million)

Cost Category	Total Costs Baseline	Incremental Costs Option 1	Option 2
Nonrecurring costs			
Acquisition and training	—	116	127
Equipment procurement	—	0	28
Construction	—	20	162
Total	—	136	317
Recurring costs			
Pay and allowances	324	–9	–4
Replacement acquisition and training	73	0	0
Support-related	57	–11	–10
Aircraft-related[a]	42	0	0
Flying hour-related[b]	283	–3	–2
Additional commercial airlift	—	11	11
Total	779	–12	–5

[a]Includes cost of replacement support equipment and the fixed portion of depot maintenance.

[b]Includes the cost of POL, maintenance material, replenishment spares, and the variable portion of depot maintenance.

Recurring cost savings proved to be quite small relative to the total cost of the C-5 program. Option 1 shows the larger estimated savings, totaling $12 million per year. Among individual cost elements the greatest savings occurred in "support related" costs, representing only a minor portion, 7 percent, of total O&S costs. Support costs include those provided by the Service or installation as a whole, such as base rentals, utilities, communications, computer operations, and medical facilities.[18] Reserve units incur lower support costs because their part-time personnel spend little time on the base. Among personnel ("pay and allowances") and equipment costs ("flying hour related" costs), only small savings occurred (for reasons discussed above), even though those cost elements composed over three-quarters of total unit costs. Finally, the relatively small O&S savings associated with the transfer were offset by the additional costs of commercial augmentation airlift, estimated at $11 million under each option.[19]

Nonrecurring transition costs appeared large compared to recurring cost savings. Initial training costs alone were estimated at approximately $120 million under each of the options. Further, construction costs (for runways and facilities) proved quite large under Option 2, which called for the establishment of an Air National Guard unit at a non-C-5 base. In total, Option 1 involved $136 million in transition costs, and Option 2, $317 million. Even ignoring the discount rate of money, those amounts imply a breakeven point of 11 and 63 years, respectively, considerably higher than acceptable levels in most program evaluations.

Table 2.12 places the cost results in the context of the resource, activity, and mission changes that accompany force structure change. Under both options, the transfer would involve the maintenance of the existing wartime mission, a real increase in AFR and ANG endstrength along with a real decrease in active endstrength, and a small decrease in military flying hours (offset by the purchase of additional

[18]These costs are only those that are considered variable; that is, they are directly attributed to a specific unit and vary by the size of that unit. The variance around that estimate is large because Service accounting practices do not allocate costs to specific units and because relatively little is known about how those costs vary with characteristics of the unit.

[19]Note that the costs of commercial airlift have not been supported by a resource analysis. The same is true for depot maintenance facilities. Because they involve nonmilitary organizations, costs in both of those areas are computed separately and included as independent cost elements in the final analysis. Exactly what types of organizations and costs are exempt from the formal analysis of resource changes in the active/reserve cost methodology are considered in the Army case study in Sec. 4.

commercial airlift). Further, the table shows that the driving force behind the cost difference between the two options is (the cost associated with) the basing arrangement—Option 1 accomplishes all the changes on existing C-5 bases, whereas Option 2 establishes a new C-5 base. Such a presentation accomplishes the goal of the methodology, relating costs to outputs in a way that enables decisionmakers to judge the desirability of various options.

Table 2.12

Comparison of Alternatives: C-5 Study

Item	Option 1	Option 2
Major equipment	Transfer of 26 C-5As to the reserves	Transfer of 26 C-5As to the reserves
Force structure	Activation and augmentation of AFR units	Activation of AFR and ANG units
Manpower		
Active	Decrease	Decrease
AFR and ANG	Increase	Increase
Wartime mission	Same (330 crews)	Same (330 crews)
Peacetime function		
Flying hours (FH)	–487	–438
Extra commercial airlift (FH)	1552	1533
Basing	Existing C-5 bases	New C-5 base
Incremental costs		
Recurring cost ($M)	–12	–5
Nonrecurring cost ($M)	136	317
Breakeven point (yr)	11	63

3. THE NAVY FF-1052 STUDY

OVERVIEW

In the spring of 1989, as military analysts searched for ways to cut the FY90–91 defense budget, changing the mix of active and reserve units was frequently proposed as a method of saving money. For the U.S. Navy (USN), it became a major budget issue.[1] One formal proposal involved the transfer of Navy frigates to the reserve (USNR) forces. At the time, the Navy operated a total of 100 frigates, 76 in the active force and 24 in the reserves, with two active ships scheduled to move to the reserves. The proposal called for transferring 24 additional frigates, all FF-1052s, to the USNR between fiscal years 1990 and 1993.

Initially, OSD analysts estimated that transferring the ships would save $550 million between fiscal years 1990 and 1994, and suggested a cost savings of about $6 million per ship per year in the steady-state. But subsequent analysis, as reported in the final Program Budget Decision (PBD), drastically reduced that estimate to less than $10 million during the transition period, and less than $1 million per ship in the steady-state. The PBD supplemented those savings, however, with a decision to reduce funding for depot maintenance of reserve ships. This supplemental decision, projected to save an additional $30 million per year throughout the transition period and thereafter, appeared to apply not only to the 24 reserve ships undergoing transfer, but to all the remaining frigates in the reserve forces as well. In spite of these estimated budget savings, within a few months of the PBD's publication, the issue of transferring the frigates was dropped from the FY90–91 budget.

This section illustrates how the active/reserve costing methodology might have been applied for a comprehensive decision analysis of the frigate transfer. Although official documentation for the final decision was unavailable, our analysis draws on information compiled from interviews with the OSD and Navy offices that analyzed the proposal. The information enabled us to approximate the same re-

[1]The emphasis on active/reserve conversions in the Navy probably resulted from the growing sense that a large number were possible. For example, former Secretary of the Navy F. Lehman stated that 150 ships, or one-quarter of the fleet, could be based in the reserve forces. (See F. Lehman, *Command of the Seas: A Personal Story*, Scribners Publishing Co., New York, November 1988.)

sult, and to extend the analysis beyond the single option addressed in the PBD.

The frigate transfer question proved an appropriate illustration and test of the active/reserve costing methodology for two reasons. First, the various analyses that were completed on the problem all had at least one of the failings that the active/reserve methodology specifically addresses: (1) too narrow a definition of the problem scope, (2) vaguely defined or missing cost elements, or (3) insufficient documentation for review. Such failings are perhaps inevitable in an environment where there is no agreed-upon methodology or set of basic cost factors and where results are demanded within hours or days. Second, the frigate transfers offer an excellent context for addressing the complex issue of how to compare alternatives in which both cost and mission capability are variable.

CASE STUDY CONCLUSIONS

The FF-1052 study demonstrates several important aspects of using the new methodology.

Use special planning tables when analyzing a large number of options. Simultaneously handling a large number of options requires special tools. This section will illustrate the use of special organizing tables to highlight option differences. Such tables can help formulate problems, design alternatives, and guide the process of completing the detailed balance sheets. The tables parallel the balance sheets in some dimensions, but require no detailed change categories or precise data, leaving the researcher free to focus on the direction of major effects.

Identify the critical cost drivers as early as possible. To produce a balanced report, cost analysts must identify critical cost drivers early in the analysis because the level of effort required can vary widely by cost driver. In the FF-1052 case, the analysis of unit operating costs (containing one set of important cost drivers) was relatively easy to quantify compared with the analysis of transition costs (containing another set of important cost drivers). Assessing those facts early in a cost study can help the analyst balance the distribution of study resources to produce a report that addresses the entire cost problem.

Distinguish force structure changes from other decisions. Active/reserve force structure changes are often mixed with other cost-cutting measures. In this case, for example, one proposed option combined force structure changes with revised maintenance procedures that would reduce depot costs for reserve ships. Such combinations are problematic when they obscure the source of cost changes.

When analyzing complex options, analysts should isolate the effects of separable cost-cutting strategies to allow separate decisions about each.

Cost support unit changes appropriately. In the active/reserve force structure methodology, some support units do not receive a full resource and activity analysis. In particular, the recurring costs (attributable to force units) of bases, training facilities, and maintenance organizations are premeasured by CERs (cost-estimating relationships) or cost factors. However, the transition costs incurred by those support organizations are not preestimated, and must be analyzed in the balance sheet process.

Distinguish between "target" and "other" units. When should units be designated as one versus the other? The difference is important because target units receive a full resource analysis (i.e., all balance sheets are filled out), whereas other units are considered only in the context of individual resource changes. Incorrectly designating some units "other" can lead to underdefined problems and underestimated costs.

Identify nonresource-related cost changes. Most sources of cost changes originate from the resource and activity analyses of the balance sheets. However, the FF-1052 case shows several examples of cost-causing changes that cannot be traced to balance sheets. They occurred when force structure changes affected unit retention rates (i.e., turnover), service prices (e.g., depot-maintenance cost factor), and the number of cost categories (e.g., the addition of personnel airlift as a cost). Analysts incorporate those changes by varying the parameters of the underlying cost model.

Present differences in mission capability. Analysts are often asked to compare costs among alternatives with unequal output. In such cases, the analyst must adequately describe those differences to place cost results into an appropriate context; even when decisionmakers seek to reduce costs, the goal is not so much the lowest cost as it is the best bargain. Although the active/reserve cost methodology captures output changes in the wartime mission or peacetime function balance sheets, the analyst may need to go beyond these tools, using the presentation of results or a table of alternative force structures, for example, to provide the proper context.

Assess the reliability of cost estimates. Estimates of savings for some force structure changes are inherently more prone to error than others. In the FF-1052 case, estimates of recurring cost savings proved to be particularly unstable in all but one option. In addition, the reli-

ability of results under one option were particularly open to question because of the use of optimistic assumptions about the size of those savings. In either case, actual cost consequences could easily diverge from those estimated. The analyst should be alert to such risks and note them in presenting results. In fact, in such cases reporting on the reliability of cost estimates can become as important as reporting the estimate itself.

DETAILED ANALYSIS

Below is the detailed analysis supporting the conclusions above and documenting how the active/reserve force structure methodology works.

PROBLEM DEFINITION

Unlike the Air Force C-5 case, the FF-1052 frigate case does not involve complex changes in force structure. Only two possible force structures were considered as alternatives to leaving the ships in the active force (the base case): transfer the ships or retire them. Under the transfer options, the active units would be disestablished and new reserve units would be created. A number of alternatives were created as variants of the transfer option, derived from methods of implementation and from alternative cost assumptions. Below, we describe the options considered for this case study.

Option 1: Standard Transfer. The standard case was developed by using a simple and straightforward set of assumptions concerning implementation. In this case, the newly acquired reserve ships would be assigned to ports and areas where the demographics suggest that sufficient personnel could be recruited to staff the unit. Home ports with available pier space would be sought, but some construction costs for pier projects would be necessary. The new reserve personnel required to man the ship would represent net additions to the force. To realize the potential savings of a reserve conversion, active end-strength would decrease, the OPTEMPO of the transferred ships would decline according to the programmed values, and the forward peacetime deployment mission of the units, no longer possible with part-time personnel, would be dropped.

The standard transfer case also reflects the two major differences between the active and reserve forces in intermediate- and depot-level ship maintenance. Intermediate maintenance is provided to all Navy ships, regardless of component, on a centralized basis—by Ship Intermediate Maintenance Activity (SIMA). However, for reserve FF-

1052s, SIMAs are required to perform organizational as well as intermediate maintenance because the part-time personnel in reserve units cannot handle all organizational-level repairs. This not only leads to substantially greater intermediate maintenance costs for the FF-1052s when transferred to reserve administration, but also suggests the need to expand SIMA facilities and workforce to accommodate the added demand. The standard case reflects this difference in maintenance costs, and assumes that SIMAs must procure additional support equipment, expand facilities, and add manpower as an indirect effect of the transfer.

Depot-level maintenance procedures have historically differed in the active and reserve forces,[2] but have been considered to involve about the same costs. However, reduced funding for depot-level maintenance of active FF-1052 frigates in recent years has led to a disparity in expenditures between components. The "standard case" will reflect this current difference between depot funding for active and reserve frigates.

Option 2: Standard Transfer with Deployment. The complete mission of FF-1052 frigates is maintained, including their forward deployment responsibilities in peacetime. This would be achieved by requiring the remaining active frigates to forward deploy more often, increasing their OPTEMPO and, because of the adverse effect on the rotation base, raising personnel turnover.[3]

Option 3: Transfer in Place, Inland Recruiting. To avoid construction costs for piers and facilities, ships could be left in their home port after the transfer. But such an option generates costs of a different kind. Since sufficient additional reserve personnel would not be available in existing home ports, recruiting would have to take place in inland areas, with personnel airlifted to ships on training weekends and for active duty tours. The airlift costs would not be insignif-

---

[2]Active FF-1052 class frigates receive maintenance under the Engineered Operating Cycle (EOC), whereas reserve frigates of the same type are maintained under the Phased Maintenance Plan (PMP). The PMP method operates on a shorter overhaul cycle than the EOC (66 months versus 88), and applies more frequent but less extensive ship maintenance. The PMP method is better suited to the training schedule of the reserve forces, because it reduces the longest period of inactivity for the ships from the eight months required for extended overhauls under the EOC method to a period of less than four months.

[3]Although an "equal effectiveness" option may appear irrelevant if analysis has already concluded that less forward deployment is warranted, this option can still measure the *flexibility* of the new force structure. Suppose that sometime after the transfer to the reserves, an increasing threat warranted a return to forward peacetime deployment at the old levels. Could the new, more reserve-dependent force structure provide what was required? At what cost?

icant. In addition, because airlifted reservists would, in effect, have to work extra hours (the additional travel time) with no pay, retention among those personnel would be lower. As a result, replacement training costs would be higher.

Option 4: Transfer in Place, Local Recruiting. This option solves the same recruitment problem by funding a major recruitment effort in the local area. However, such an effort would probably result in a smaller proportion of more experienced prior-service personnel and, therefore, in longer and more costly training programs.

Option 5: Transfer in Place, Within Reserve Endstrength. Achieving more substantial savings than those described above would require significant reductions in either manpower or ship activity levels. Under Option 5, manpower would cost less because the new reserve units would be manned without increasing endstrength, by drawing manpower from existing, lower priority units. One way to implement this option would be to staff the new reserve ships with reserve augmentees currently serving on other active ships. Although it would generate substantial manpower savings, this option would also require airlift for the unit's reservists and would reduce the mission capability of the units losing manpower.

Option 6: Standard Transfer, Low Cost Assumptions. This "low-cost" alternative assumes favorable resolution of all major problem uncertainties, thus attributing maximum savings to the frigate conversions. It assumes, for example, that new ports can be located with both sufficient pier space and favorable demographics, thus avoiding the need for special recruitment programs or construction expenditures.[4] Further, it assumes that SIMA facilities in those same locations can absorb additional reserve ship maintenance without modifying facilities or acquiring equipment. Finally, it assumes that reserve depot-maintenance procedures can be redesigned so that the per-ship costs could be lowered to current active levels, and that the accompanying savings in depot maintenance accrue not only for the 24 ships under study but also for other reserve frigates. All of these assumptions were included in the PBD. We create this option here both to imitate the option costed in the PBD and to produce an upper-bound estimate on potential savings from the transfers.

Option 7: No Transfer, Retire Ships. Under this option, instead of transferring the ships to the reserves, they are mothballed or placed

---

[4]This might be possible under the Navy's strategic home porting program, which expands the number of potential areas for FF-1052 reserve basing.

on inactive reserve status. The FF-1052s are the oldest and least capable of the Navy frigates, and the Navy had been reducing their maintenance levels by forgoing major overhauls. This option would save the manpower and equipment costs of reserve operation, but would entail the complete loss of the FF-1052 mission.

Dealing with a large number of options involving a wide variety of differences requires special tools. Tables 3.1a and 3.1b summarize the seven case options according to the five basic components of unit change (mission, function, manpower, equipment, and basing) and by distinguishing between effects on "target" and "other" units. Column 1 describes the "standard transfer" case, whereas columns 2 through 7 note only the differences for the other options. The tables act as worksheets for analysts; they aid the process of defining problems and setting up alternatives, and they call for qualitative information useful in completing the detailed balance sheets.

Tables 3.1a and 3.1b provide considerably more information than the verbal description above. For example, consider Option 6, the low-cost assumptions case. This option assumes that recruiting problems will lead to manpower shortages in the newly created reserve units, allowing increases in other, nonspecified reserve units. (This occurs because endstrength ceilings are expected to remain constant, regardless of how many personnel the reserve ships are able to recruit.) Tables 3.1a and 3.1b show that when compared with the standard case, manpower in the target units (the FF-1052s) will be less, but that to meet endstrength levels, manning in other reserve units has to be increased.

Note that all the options considered have some effect on nontarget units. Five of the seven expand the support equipment and facilities of SIMAs,[5] the organizations that provide intermediate maintenance for FF-1052s. For four of the seven alternatives, nontarget combat

[5]Note, however, that the table does not include other effects on SIMAs. For example, ship transfers would surely affect SIMA OPTEMPO because, as explained above, SIMAs must take over some of the organizational maintenance functions of the FF-1052s after the change. In fact, changes in SIMA resource and activity levels need be reflected only if they affect nonrecurring costs. This is true because changes in the recurring costs of SIMAs are automatically captured by the active/reserve cost methodology. The same would be true for depot maintenance facilities. (See cost calculations discussion below.)

Table 3.1a

Alternatives for Transferring Navy Frigates to the Reserve Forces: Effect on Transferring Units, FF-1052 Study

	Changes	Changes Compared to the Standard Case					
Type of Unit Transformation	Option 1: Standard Case	Option 2: Standard Case with Deployment	Option 3: Transfer in Place/Inland Recruiting	Option 4: Transfer in Place/Local Recruiting	Option 5: Transfer in Place/Same R Endstrength	Option 6: Standard Case/Low-Cost Assumptions	Option 7: No Transfer/ Retire Ships
Mission	Transfer to reserves	(a)		Transfer takes longer to realize		Plus reserve capability decrease	Loss of mission
Peacetime function	OPTEMPO declines						OPTEMPO eliminated
	Loss of forward deployment						
Manpower	Active manning decrease		Plus increased reserve turnover	Plus lower prior service accessions	Plus increased reserve turnover		
	Reserve manning increase		Increased transportation required	Increased recruitment effort	Increased transportation required	Smaller reserve increase	No reserve increase
Equipment	No change						24 FF-1052s retired
Basing	Pier projects		No projects	No projects	No projects	No projects	No projects

NOTE: See text for definition of options. All alternatives (except number 7) assume that existing Navy units will be deactivated and new reserve units established. The base case upon which entries are based is that the transfers will not occur.

[a]No entry means same as standard case, Option 1.

Table 3.1b
Alternatives for Transferring Navy Frigates to the Reserve Forces: Indirect Effects on Other Units, FF-1052 Study

	Changes	Changes Compared to the Standard Case					
Type of Unit Transformation	Option 1: Standard Case	Option 2: Standard Case with Deployment	Option 3: Transfer in Place/Inland Recruiting	Option 4: Transfer in Place/Local Recruiting	Option 5: Transfer in Place/Same R Endstrength	Option 6: Standard Case/Low-Cost Assumptions	Option 7: No Transfer/ Retire Ships
Mission	No change	(a)			Reserve capability decrease	Reserve capability increase	Active capability increase
Peacetime function	No change	OPTEMPO Increase More forward deployment					
Manpower	SIMA manning increase	Plus active turnover increase			Plus reserve manning decrease	No SIMA effect Reserve manning increase	No SIMA effect Active manning increase
Equipment	SIMA support equipment procured					No procurement	No procurement
Basing	SIMA facilities expansion					No expansion	No expansion

NOTE: See text for definition of options. All alternatives (except number 7) assume that existing Navy units will be deactivated and new reserve units established. The base case upon which entries are based is that the transfers will not occur.

[a]No entry means same as standard case, Option 1.

units are indirectly affected. In Option 2, the case that keeps the deployment mission, the effect is on the remaining active FF-1052 units. In Options 5 and 6, the effect is on other, unspecified reserve units, whereas the effect in the "no transfer" option (Option 7) is on unspecified active units.

The distinction in Tables 3.1a and 3.1b between "target" and "other" units is important; target units receive a full resource analysis, whereas "other" units are considered only in the context of individual resource changes. For example, in Option 6, reserve manning increases for some unspecified reserve units, but the question is not asked (as the balance sheets would force one to do) whether manning changes in those units affect other aspects of those units—such as activity levels.

Analysts begin by specifying the most directly affected units (the FF-1052s) as target and then decide, as they discover indirectly affected units through the balance sheet process, whether to add to the target list. Although deciding to designate a unit as "target" will inevitably involve judgment, three general criteria apply. First, the change should be large enough so that complex effects are likely. Second, "other" units can be made "target" units if those units, in turn, are likely to have indirect effects on yet other units. Third, a full resource analysis must be possible. If units are unspecified, as when personnel from deactivated units are redistributed throughout the force, then full unit-based resource analyses cannot be performed.

In our example, "other" units could have reasonably been made into "target" units only for Option 2, the case that maintains the peacetime mission. In that case, the active FF-1052 units are clearly identified "other," and the effects are as large as on the target units. In actuality, because the effects on those other units did not appear to be overly complex, we left them as "other" and instead were careful to include all the effects on those units (e.g., on turnover rates) outside the balance sheet context.

RESOURCE AND MISSION ANALYSIS

We show the resource and mission changes implied by the options described above, the unit transaction balance sheet methodology. All changes in the balance sheets are compared with the base case of leaving the ships in the active force.

Wartime Mission

Capturing mission changes is particularly important when proposals for changes in force structure are combined with other measures to control unit costs. Changes in mission are indicated by changes in: (1) unit mission statements, (2) force structure, (3) resources available to complete a mission, or (4) unit characteristics that measure or relate to unit performance. The Navy case study has examples of all four types of measures.

The FF-1052 transfers have a clear effect on force structure and unit mission statements. The FF-1052 frigates, designed for antisubmarine warfare, conduct ocean escorts both in wartime and peacetime as part of the Navy's forward deployment mission. Table 3.2 describes alternative changes in the frigates' mission. In Option 7, that mission is lost entirely (although, because mission personnel are transferred and endstrength remains the same, capability in other units increases). In the other options, the ships are maintained for immediate availability, but without forward deployment capability in peacetime, because the training schedule of part-time reservists does

Table 3.2

Change[a] in Mission: FF-1052 Study

Change Option	Target Units		Transfer from/to	Net
	Additions	Subtractions	Other Units	Change
Options 1–7: USN FF-1052 mission		–		–
Options 1–6: USNR FF-1052 mission	+			+
Option 4: Time to readiness		–		–
Option 5: Mission capability USNR			–	–
Option 6: Mission capability USNR		–	+	+,–
Option 7: Mission capability USN			+	+

[a]Options compared with the baseline case of not transferring the ship. Alternatives are:

Option 1: Standard transfer.
Option 2: Standard transfer, with deployment.
Option 3: Transfer in place, inland recruiting.
Option 4: Transfer in place, local recruiting.
Option 5: Transfer in place, within reserve endstrength.
Option 6: Standard transfer, low-cost assumptions.
Option 7: No transfer, retire ships.

not allow for the sustained time commitments that forward deployment demands.[6]

Other changes in capability are less straightforward. Option 5 results in a decrease in capability because of reduced resources for the frigates' mission. New reserve units are staffed without an increase in reserve endstrength, which can be accomplished only by drawing down the personnel assigned to other (less critical) units, thus decreasing their capability.

Option 6 (low-cost assumptions) implies a reprioritization of missions with an uncertain effect on overall capability. Under that option, the FF-1052 reserve ships are expected to have difficulty recruiting qualified reservists, resulting in a decrease in those units' capability. However, since reserve endstrength will reflect the full manning requirement, greater manning is expected in other reserve units, resulting in an increase in those units' capability.

Finally, Option 4 results in a temporary decrease in the capability of FF-1052 units. That case depends on a stepped-up recruiting effort in areas short on untapped reserve prior-service manpower. As a result, it is expected that units will have to rely on the training of new non-prior service personnel, a process that will extend the time it takes to make the ships mission ready.

Because the changes presented in Table 3.2 are difficult to measure, they are not expressed quantitatively. Instead, plus (+) and minus (–) signs indicate the direction of change. Qualitative measures of mission change are sufficient because in the cost analysis decisionmakers are expected to make their own judgments about significance.

Peacetime Function

In peacetime, FF-1052 frigates complete unit training and provide ocean escorts as part of the Navy's forward deployment policy. For costing purposes, the ship's function can be measured by operating tempo, which has two components: steaming days underway and days in port. Reserve ships spend more days in port, resulting in a lower cost of operation.

Table 3.3 summarizes changes in OPTEMPO for each of the seven alternatives. For most options, days in port are substituted for steaming days underway. (OPTEMPO changes are listed on a per-ship ba-

[6]Changes in forward deployment responsibilities are recorded in Table 3.3 because they are technically a "peacetime function" of the unit.

sis and would be multiplied by 24 to obtain final results.) Option 2, on the other hand (the option that maintains forward deployment levels), shows that changes in the transferring units are exactly compensated for by opposing changes in other active units, which will spend more time at sea and less time in port. The net effect on OPTEMPO is zero. Finally, Option 7, which calls for the retirement of the frigates, replaces operational costs with much smaller storage costs.

Table 3.3 adheres to the logic of balance sheet construction. For example, the table can include the individual effects on both active and reserve units without requiring separate tables because all the negative signs and numbers refer to the active units, whereas all the positive numbers refer to reserve units. Also, steaming days and days in port are listed on the same line in active and reserve units because the cost per day is the same for both components. If cost factors differed between the components (e.g., if active and reserve ships oper-

Table 3.3

Change[a] in Peacetime Function per Ship: FF-1052 Study

Type of Function	Target Units		Transfer from/to Other Units	Net Change
	Additions	Subtractions		
	Option 1, 3, 4, 5, 6			
Forward deployment mission		–		–
Steaming days underway	84	–144		–60
Days in port	276	–215		61
	Option 2			
Forward deployment mission		–	+	0
Steaming days underway	84	–144	60	0
Days in port	276	–215	–61	0
	Option 7			
FF-1052 Peacetime mission		–		–
Steaming days underway		–144		–144
Days in port		–215		–215

[a]Options compared with the baseline case of not transferring the ship. Alternatives are:

Option 1: Standard transfer.
Option 2: Standard transfer, with deployment.
Option 3: Transfer in place, inland recruiting.
Option 4: Transfer in place, local recruiting.
Option 5: Transfer in place, within reserve endstrength.
Option 6: Standard transfer, low-cost assumptions.
Option 7: No transfer, retire ships.

ated a different number of hours per day when steaming), separate listings would be required.

Manning

Transferring FF-1052 missions to the reserves implies a cost savings due to the part-time nature of the reserve workforce. Table 3.4 shows the summary manning implications of one FF-1052 ship transfer. As in the peacetime function balance sheet, the subtractions under target units refer to the change on the active side, whereas the additions refer to the change in the reserves. Active units have some part-time reserve personnel (under the Navy's augmentee program), and reserve units have some full-time active personnel. It is expected that some of the active and reserve personnel will stay with the ship after the conversion to become a part of the new reserve unit, offsetting the need to obtain the full complement of personnel for the new unit.

For Options 1 through 4, the manning implications are the same—a decrease in active personnel, an increase in reserve personnel, and no effect on nontarget units. Under Option 6, the arithmetic is slightly different but leads to the same result. For that option, recruiting problems will lead to fewer additions to target units and, because endstrength ceilings will not change, an increase in nontarget units. In contrast, Options 5 and 7 cause no changes in active manpower because the endstrength ceilings remain constant. Further, Option 7 leaves reserve endstrength constant because no new reserve units are created.

Some resource factors related to manpower cannot be captured in the manpower balance sheet. Option 4 has higher training costs because fewer recruits are expected to be prior-service personnel. Options 2 and 3 increase manpower replacement cost because turnover rates are expected to be higher. Prior-service and turnover factors relate to the flow of personnel rather than their number at any point in time. Changes in these factors are accounted for in the design of the cost model (see the discussion of cost consequences below.)

Equipment and Basing

The PBD analysis assumed that suitable pier space could be found at existing ports, and that existing SIMAs could absorb the additional work without modifying facilities, expanding workforces, or purchas-

Table 3.4

Change[a] in Manpower per Ship: FF-1052 Study

Type of Manpower		Target Units: Additions	Target Units: Subtractions	Transfer from/to Other Units	Net Change
		Active Personnel			
Options 1–6:					
	Officer	4	–19		–15
	Enlisted	100	–271		–171
Option 7:					
	Officer		–19	19	0
	Enlisted		–271	271	0
		Reserve Personnel			
Options 1–4:					
TAR:	Officer	5			5
	Enlisted	76			76
SELRES:	Officer	9	–5		4
	Enlisted	129	–56		73
Option 5:					
TAR:	Officer	5		–5	0
	Enlisted	76		–76	0
SELRES:	Officer	9	–5	–4	0
	Enlisted	129	–56	–73	0
Option 6:					
TAR:	Officer	3		2	5
	Enlisted	60		16	76
SELRES:	Officer	7	–5	2	4
	Enlisted	105	–56	24	73
Option 7:					
SELRES:	Officer		–5	5	0
	Enlisted		–56	56	0

[a]Options compared with the baseline case of not transferring the ship.

Alternatives are:

Option 1: Standard transfer.
Option 2: Standard transfer, with deployment.
Option 3: Transfer in place, inland recruiting.
Option 4: Transfer in place, local recruiting.
Option 5: Transfer in place, within reserve endstrength.
Option 6: Standard transfer, low-cost assumptions.
Option 7: No transfer, retire ships.

ing equipment.[7] Navy experience, however, suggests that these assumptions would prove unworkable. A recent study examining the introduction of four FF-1052s at San Francisco and two at New York concluded that the following nonrecurring transition costs would be incurred: pier projects averaging $8.75 million per ship, SIMA construction projects averaging $3.3 million per ship, and SIMA support equipment purchases averaging $1.73 million per ship.[8]

In the absence of published nonrecurring cost factors for reserve conversions,[9] we used the figures cited above for this study. Although the generalizability of those factors is unknown, we believe they are sufficiently accurate to support the point that transition cost factors can play a critical role in differentiating among cost study outcomes.

Assumptions about equipment and basing are recorded in Table 3.5, the equipment and basing balance sheets. Options 1 and 2 incur more costs than the other alternatives. Navy programs, like the strategic home porting program,[10] will probably permit some reserve ships to be absorbed without significant transition costs. It is assumed that, on average, the transfers will require half the investment specified by the cost factors, with the remainder representing a draw on excess capacity. In recording the information in balance sheet form, we list the SIMA costs in the "other" column rather than the "addition" column, because those organizations are not "target" units.

Like the formal budget analysis, all the other options assume zero construction expenditures on pier projects. SIMA transition costs, on the other hand, are considered unavoidable except in the case that makes low-cost assumptions and in the case that retires the ships. Because Options 3 through 6 represent simple variations of the full-cost options, they are not recorded in the table. The table does record

[7]In fact, OSD imposed the restriction that the transfers be accomplished without incurring military construction (MILCON) costs.

[8]See John F. Schank, S. J. Bodilly, and A. A. Barbour, *Cost Analysis of Reserve Force Change: Nonrecurring Costs and Secondary Cost Effects*, RAND, R-3492-RA, May 1987, p. 24.

[9]Factors for FF-1052 transfers could have been developed, since the Navy has been converting frigates to the reserves since the early 1980s.

[10]The strategic home porting program expands the number of ports available for ship basing.

Table 3.5

Change[a] in Equipment and Basing per Ship: FF-1052 Study

Type of Unit Transformation	Target Units		Transfer *from/to* Other Units	Transfer from/to Excess Capacity	Net Change
	Additions	Subtractions			
Options 1, 2					
FF-1052s	24	−24			0
Pier projects ($M)	8.750			−4.375	4.375
SIMA facilities ($M)			3.300	−1.650	1.650
SIMA support equipment ($M)			1.730	−.865	.865
Option 7					
FF-1052s		−24		+24	0

[a]Options compared with the baseline case of not transferring the ship. Alternatives are:

Option 1: Standard transfer.
Option 2: Standard transfer, with deployment.
Option 3: Transfer in place, inland recruiting.
Option 4: Transfer in place, local recruiting.
Option 5: Transfer in place, within reserve endstrength.
Option 6: Standard transfer, low-cost assumptions.
Option 7: No transfer, retire ships.

Option 7, however, to show the positive excess capacity entry representing the ship placed in mothballs. The net effect in that case is still zero, because the ships could be brought out of mothballs. A net negative effect for major equipment could result only from foreign military sales or from a decision to scrap the ships.

COST CONSEQUENCES

Calculating Costs

Calculating the costs of transferring the FF-1052 frigates to the reserve forces required a cost model to map the information on resource and activity changes (in the balance sheets above) into a comprehensive set of costs. The generic cost model used for analyzing changes in the active/reserve mix is documented in R-3748/1-PA&E/FMP/JCS. We supply here the particulars that allow the application of the general model to our particular case. We need a set of resource, cost, and intermediate factors that apply to FF-1052 frigates undergoing conversion to the reserve forces.

Table 3.6 supplies the resource factors—the table lists the net resource and activity changes calculated earlier in this section. The perspective is forcewide, with distinctions among target and other units made only when necessary to properly identify changes (e.g., SIMA support equipment). Unit designations are unnecessary for costing purposes; for example, steaming days are the same for FF-1052s whether completed by active or reserve units.

Note that the table does not include all the support units' resource and activity changes. For example, although the ship transfers would surely affect the operating tempo of SIMA organizations, Table 3.6 contains no measures of those activities because such changes are already captured by cost factors or CERs in the active/reserve costing methodology. Those factors, in effect, preestimate the resource (and cost) impact of force structure change using a single cost driver (e.g., for SIMAs, the number of ships).

What holds true for SIMAs also holds true for other organizations. The active/reserve force structure model contains cost factors that capture the effect of force unit changes on supporting depots, training organizations (i.e., the training cost factors include costs for instructors and the operation of training facilities), and base operating facilities. In general, changes in those organizations' resource and activity levels need be captured only in the balance sheets if they relate to the transition period and nonrecurring costs. For example, the SIMAs

Table 3.6

Summary of Resource and Activity Changes per Ship: FF-1052 Study

Category	Net Change						
	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7
Function							
Steaming days underway	–60	0	–60	–60	–60	–60	–144
Days in port	61	0	61	61	61	61	–215
Manpower							
Active							
Officer	–15	–15	–15	–15	–15	–15	0
Enlisted	–171	–171	–171	–171	–171	–171	0
Reserve							
TAR							
Officer	5	5	5	5	0	5	0
Enlisted	76	76	76	76	0	76	0
SELRES							
Officer	4	4	4	4	0	4	0
Enlisted	73	73	73	73	0	73	0
Equipment							
SIMA support equip. ($M)	.87	.87	.87	.87	.87	0	0
Basing							
Pier projects ($M)	4.38	4.38	0	0	0	0	0
SIMA facilities ($M)	1.65	1.65	1.65	1.65	1.65	0	0

NOTE: Alternatives are:

Option 1: Standard transfer.
Option 2: Standard transfer, with deployment.
Option 3: Transfer in place, inland recruiting.
Option 4: Transfer in place, local recruiting.
Option 5: Transfer in place, within reserve endstrength
Option 6: Standard transfer, low-cost assumptions.
Option 7: No transfer, retire ships.

involved with the FF-1052 conversions were expected to have to expand facilities and purchase additional support equipment. No cost factors currently exist that estimate the transition cost impact of ship conversions.

Table 3.7 lists most of the cost factors used for this study. Each factor has an implied resource analysis behind it. For example, the calculation of intermediate maintenance cost per reserve ship takes into account all the manning and equipment-related resource changes within SIMAs associated with servicing a reserve ship. Since the Navy does not publish a readily available cost factor handbook, no claims for accuracy in the factors are made. They were simply drawn from documentation obtained from the various analyses of the FF-1052 budget issue in OSD and the Navy. In most instances, more than one choice for a factor was possible, with not always a clear reason for choosing one over another. For internal consistency we tried to draw from as few sources as possible.

In general, the costs are computed by multiplying the net changes in resource and activity factors (e.g., those compiled in Table 3.6 above) by cost factors (e.g., those compiled in Table 3.7 above). For example, pay and allowances were calculated by determining the change in manning, then multiplying that change by the cost per man.

However, some cost elements require intermediate factors (see Table 3.8). Replacement training costs of unit personnel, for example, depend on the turnover rate (because it determines the number of personnel that require training) and the proportion of prior-service personnel (because it determines the type and cost of training required).

Because intermediate factors can change with differing force structures and can affect cost, analysts need to consciously choose their values. For example, Option 3 predicts a change in the retention rate (turnover) for part-time reservists. Instead of a rate of 0.19 for reserve officers used in the standard case (see Table 3.8), the value rose to 0.25. Option 4 involved a change in the prior-service factor of the standard case because such personnel were known to be less available. Instead of 66 percent for enlisted part-time reservists used in the standard case, the value was assumed to be 40 percent. In both those cases, the nature of the force structure change directly caused the change in the intermediate factor; in turn, both those changes had a significant effect on costs.

Table 3.7

Selected Cost Factors: FF-1052 Study

Item	Amount ($)
Manpower cost	
Officer	
Active	62967
TAR	69421
SELRES	10241
Enlisted	
Active	27608
TAR	30118
SELRES	3739
Training cost	
Acquisition	
Officer	89000
Enlisted	21000
Skill training	
Officer	46508
Enlisted	18935
SIMA recruitment cost	3219
Support-related cost	
Full-time personnel	5546
Part-time personnel	1604
OPTEMPO cost	
POL/barrel	21
Utilities/day in port	
Active	1581
Reserve	2286
Ship-related costs	
Repair parts	777,000
Depot maintenance	5,192,000
Training munitions	474,000
Other costs	
MILCON/ship	8,750,000
SIMA MILCON/ship	3,300,000
Other supply cost/FTME[a]	1084
IMA[b] cost/man-year	17680
IMA material cost/ship	52000
Lift cost/SELRES	6000

[a]FTME = Full-time manning equivalent.

[b]IMA = Intermediate Maintenance Activity.

Table 3.8

Selected Intermediate Factors: FF-1052 Study

Item	Amount
Manpower turnover	
Officer	
Active	0.09
TAR	0.19
SELRES	0.19
Enlisted	
Active	0.19
TAR	0.30
SELRES	0.30
Proportion prior service	
Officer	
Active	0.00
TAR	1.00
SELRES	0.79
Enlisted	
Active	0.00
TAR	100.00
SELRES	0.66
Other	
Hours underway/steaming day	19.00
Hours not underway/hours underway	
Active unit	0.44
Reserve unit	0.84
Fuel (barrels)/hour underway	17.5
Fuel (barrels)/hour not underway	5.6
IMA man-years required	
Active unit	13.4
Reserve unit	70
Productivity of IMA man-years	0.45
SIMA personnel/ship	100
Steaming days underway/year	
Active	144
Reserve	84

Comparing Options

Table 3.9 compares the recurring costs of an FF-1052 class frigate as it would operate under active and reserve administration. The cost-element list, divided into personnel-related and equipment-related categories, differs somewhat from the C-5 case because of differences in both the nature of the weapon systems and the ways those systems are operated and maintained. Costs are compared by the difference

Table 3.9

Recurring Costs of FF-1052 Frigates, by Component: FF-1052 Study

Cost Category	Costs of FF-1052 ($M) USN	USNR	Comparison Difference ($M)	Ratio
Personnel-related costs				
Pay and allowances	8.9	6.2	−2.7	0.70
Replacement acquisition and training	2.6	1.6	−1.0	0.61
Support-related	1.7	1.2	−0.5	0.73
	0.3	0.2	−0.1	0.70
Total	13.5	9.2	−4.3	0.68
Equipment-related				
OPTEMPO-related				
POL	1.1	0.7	−0.4	0.65
Utilities	0.4	0.5	0.1	1.28
Ship-related				
Depot maintenance	3.8	5.2	1.4	1.35
Intermediate maintenance	0.6	2.8	2.2	4.84
Repair parts	0.8	0.8	0	1.00
Training munitions	0.5	0.5	0	1.00
Total	7.2	10.5	3.3	3.3
Grand total	20.8	19.8	−1.0	0.95

and the ratio of the two unit costs. Overall, Table 3.9 shows that the reserve FF-1052 costs less to man and operate but more to maintain. The net effect is an estimated savings in recurring operating and support costs of $1 million. This is a small percentage of total unit costs but, multiplied by 24, amounts to the sizable savings of $24 million per year.

However, the estimated $24 million savings is difficult to rely on for three reasons. First, because the cost difference is small in percentage terms, a small error in one or both of the components could turn the cost effect in the opposite direction. Second, the estimate carries a high risk because any systematic errors would be repeated 24 times—if a cost element had been omitted or severely underestimated, the error would repeat 24 times. In contrast, if 24 independent active/reserve conversions were to be undertaken, errors (both systematic and unsystematic) would tend to cancel rather than add. Third, the estimate carries a high risk because of the limitations of the underlying cost model, which assumes only a small change in

force structure. A change that involves 24 units is perhaps large enough to challenge the assumption that certain overhead elements remain fixed in the particular application.

Table 3.10 compares the cost consequences of the various study options. The first column contains the recurring cost differences for the standard case (Option 1, obtained from Table 3.9), and adds nonrecurring costs specific to the FF-1052 transfers. The remaining columns show how the cost consequences of the standard case differ from the other options; information about the other options is given only when it differs from the standard case. In general, differences among the options reflect the various ways the conversions would be implemented. For example, for Option 5, which adds reserve units without increasing reserve endstrength, Table 3.10 shows the increased savings in personnel-related cost elements on the one hand, and the addition of airlift costs to bring existing reservists to their new home ports on the other hand.

Table 3.11 uses summary information on recurring and nonrecurring costs to compute the "payback period" for each of the options—the time it would take recurring cost savings to pay back the cost of transition. The payback period varies widely among the options, from less than a year to more than 17. The table makes it clear that achieving immediate savings (in less than a year) from transferring the frigates requires either drastic action (such as holding reserve endstrength constant, Option 5), or a willingness to make consistently optimistic assumptions about the costs of implementation (Option 6).

RESULTS

Table 3.12 places the cost results in context by comparing selected alternatives according to a wide range of effects, including those related to changes in mission, function, manpower, equipment, basing. The table focuses on two of the options that have significantly different consequences: the standard case (Option 1), and Option 6, the alternative that comes closest to the one costed in the PBD.

Table 3.12 shows not only that Option 6 offers more favorable cost results, but why. That option assumes that transition costs, in the form of pier projects and SIMA-related costs, can be avoided entirely, and that reserve ships can be properly maintained on a substantially reduced budget. However, the table also records the uncertainty surrounding those assumptions, indicating that the actual costs of implementation may be higher.

Table 3.10

Cost Consequences of Options Compared with Standard Case: FF-1052 Study

Cost Category	Changes ($M)	Incremental Changes ($M) Compared with Standard Case					
	Standard Case Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7
Nonrecurring costs							
Acquisition and training	2.6			2.2	–2.4		–2.6
Military construction	4.4		–4.4	–4.4	–4.4	–4.4	–4.4
SIMA-related	2.8					–2.8	–2.8
Other, mothballing ship							.4
Recurring costs							
Pay and allowances	–2.7				–3.0		2.7
Replacement acquisition and training	–1.0	5.1	.3	5	–.7		1.0
Support-related	–.5				–.6		.5
Supplied	–.1				–.1		.1
Personnel airlift	0		.5		.5		
POL	–.4	.4					–.7
Utilities	.1	–.1					–.5
Depot maintenance	1.4					–1.4	–5.2
Other ship-related	2.2						–4.1

NOTE: Alternatives are:

Option 1: Standard transfer.

Option 2: Standard transfer, with deployment.

Option 3: Transfer in place, inland recruiting.

Option 4: Transfer in place, local recruiting.

Option 5: Transfer in place, within reserve endstrength.

Option 6: Standard transfer, low-cost assumptions.

Option 7: No transfer, retire ships.

Table 3.11

Summary of Cost Consequences: FF-1052 Study

Option	Description	Cost ($M) per Ship		Payback Period (years)[a]
		Nonrecurring	Annual Recurring	
1	Standard transfer	9.8	−1.0	9.8
2	Standard transfer, with deployment	9.8	4.4	—
3	Transfer in place, inland-recruiting	5.4	−.3	17.1
4	Transfer in place, local recruiting	7.6	−.5	15.5
5	Transfer in place, within reserve endstrength	3.0	−5.4	.6
6	Standard transfer, low-cost assumptions	2.6	−3.7	.7
7	No transfer, retire ships	.4	−7.2	.1

[a]Computed by dividing nonrecurring costs by the annual recurring costs. Numbers may appear slightly off due to rounding of cost figures. For simplicity, calculations assume zero discount rate; higher discount rates would increase break-even points.

Finally, Table 3.12 clarifies the source of savings, distinguishing between monies that would be saved by the decision to transfer the ships to the reserves and monies that would be saved by the decision to reduce depot maintenance funding in the reserves. The distinction is important because the depot maintenance and force structure decisions are separable and have very different effects on costs. By itself, the force structure decision in Option 6 would save an estimated $1 million per ship, but would require 2.6 years to pay the transition costs. In contrast, the depot maintenance decision could capture $3.7 million in savings beginning immediately. Combined, the decisions could save $4.7 million beginning after 0.7 year.

Table 3.12

Comparison of Selected Alternatives: FF-1052 Study

Effect	Option 1 Standard Transfer	Option 6 *Low-Cost Assumptions*
Force structure change	Transfer 24 FF-1052s to USNR	Same as standard
Unit change	24 deactivations 24 new units established	Same as standard
Depot maintenance policy	No change	Lower-cost maintenance in reserves
Mission	Transfer to reserve mission	Same as standard, but mission emphasis shifted
Manpower	Active endstrength decrease Reserve endstrength increase	Same as standard, but reserve endstrength shifted
Peacetime function	OPTEMPO decline Loss of forward deployment	Same as standard
Equipment	SIMA support equipment	Assume not required
Basing	Pier projects SIMA facilities	Assume not required
Incremental cost per ship ($M)		
Recurring savings		
Force structure change only	1.0	1.0
With change in depot policy	3.7	3.7
Nonrecurring costs	9.8	2.6
Payback period (years)		
Force structure change only	9.8	2.6
With change in depot policy	2.6	.7
Executability	Proven	Uncertain

4. THE ARMY AH-64 STUDY

OVERVIEW

In 1985, the Army introduced the new AH-64 Apache attack helicopter into the Army National Guard as part of its equipment modernization program. This decision was unique not only because the Guard was receiving new equipment at the same time as the active Army, but also because the AH-64 was the Army's first high-technology aviation weapon system. As a result, the Guard was receiving a weapon system at a time when there were still a great many uncertainties as to how that system should be manned and equipped.

The largest uncertainty surrounding the placement of the AH-64 in the Guard was whether a part-time force could maintain the level of readiness in training, equipment, and personnel that was required for a C-1 rating in a unit with a highly technical weapon system. Could the Guard recruit aviators and other personnel who would accept the demanding flying-hour program they would have to sustain, and could those personnel be induced to stay after experiencing those conditions? Would civilian employers of potential AH-64 unit members cooperate in making appropriate time available for the extensive initial training the new weapon system would require? Could a largely part-time force maintain such an advanced technology weapon system?[1]

Unlike the other case studies in this report, cost does not appear to have been a major issue in the final decision to place the AH-64 in the reserve forces. As far as we know, there were no published studies that examined the cost implications of placing the equipment in the Guard instead of the active Army or the Army reserve. We chose the Apache as a case study because it offered an opportunity to test the methodology in a number of contexts that had not previously been tested; the case represented a new type of force structure change (a

[1]Through the design of innovative implementation strategies, the AH-64 experiment in the Guard has apparently proven a success. A newly designed training program has maximized home station training during the transition, and public relations programs have convinced employers to accommodate the guardsman's more demanding part-time job. Moreover, recruitment efforts have proven successful (the unit currently has manpower inventories of 122 percent of authorizations), and despite extra flight training periods, turnover has not posed a problem (13 percent for the first year of operation). Finally, current plans call for expanding the role of the reserve forces to 15 battalions in all, two in the Army reserves, and 13 in the Army National Guard. At that level, roughly one-third of AH-64 battalions would reside in the reserve forces.

modernization), a new type of unit (an Army aviation battalion), and a change that was a new mission for the Guard.

This section focuses on the first Guard battalion to receive the AH-64s, North Carolina's 1st Battalion, 130th Aviation Regiment. It was formerly an AH-1 battalion and is located adjacent to Raleigh-Durham International Airport. The first Military Occupational Specialty (MOS) training for unit aviators and enlisted personnel began in January 1986; by August 1988, the unit had completed battalion-level training and evaluation.

CASE STUDY CONCLUSIONS

The AH-64 case demonstrates several important aspects of using the new methodology.

Define the problem to focus on incremental costs. One benefit of proper problem definition is the ability to focus analysis resources on costs that are most relevant to the decision at hand. For example, costs that are common to all the options do not require precise calculation. In the AH-64 case, this allowed analysts to ignore the "domino effect" of equipment modernization, and to concentrate on the costs of the primary modernization.

Treat a modernized unit as two separate (the old and new) units. When analyzing changes in a modernized unit in the balance sheet context, flows can be better understood if the unit is considered as two. In the present case, the old AH-1 units have been considered separately from the new AH-64 units. This clarifies, for example, the source and disposition of all unit personnel, which, in turn, aids in the computation of personnel training and processing costs.

Report joint front-end costs separately. Because the AH-64 unit was new to the Guard and because that unit was expected to maintain a C-1 readiness rating, there were substantial front-end costs in designing and implementing a fielding plan that would be feasible for part-time Guard personnel. However, because those costs could not be reasonably allocated (in this case, because an unknown number of units outside the case study would benefit), we recommended that they be presented separately from other decision costs.

Treat unfunded expenditures as resource reallocations. In some force structure decisions, some of the costs may go unfunded, leaving it up to the Services to pay the bill by diverting money from other accounts. Such costs are *not* additional expenses attributable to the force structure change, simply because they do not represent a net additional

expenditure of money. Conversely, the costs are not free, since a price is paid. Instead, unfunded changes are properly recognized as a reallocation of resources, the accomplishment of a force structure change at the expense of reducing the capability of other units (because those units have fewer resources to accomplish the same mission).[2]

Adapt the methodology to the procedures of each service. The active/reserve costing methodology for aviation units was designed from costing experience in the Navy and Air Force. However, the AH-64 study suggests that using the methodology for Army aviation units will require some adaptation. First, because Army units of the same type appear to be less uniform (e.g., the number of assigned personnel in Army National Guard units can not only be substantially less than the authorized level—as is true in the other Services—but can also be substantially more), the analyst can place less reliance on generic cost factors. Second, because force structure units in the Army tend to be more organizationally complex than in the Air Force or Navy (e.g., Army aviation units require multiple weapons within the same unit and spread maintenance among four separate organizations instead of three), the analyst should expect increased complexity in the calculation of cost elements.

Create appropriate output measures. The distinction in the active/reserve costing methodology between the nonrecurring transition costs of a force structure change and the steady-state recurring costs invites the analyst to compare alternatives on that basis. However, when the transition period differs substantially among options (as it does in the AH-64 case), more sophisticated cost measurements are required, such as the computation of net present values.

DETAILED ANALYSIS

Below is the detailed analysis supporting the conclusions above and documenting how the active/reserve force structure methodology works.

PROBLEM DEFINITION

The question "What is the cost of modernizing the Army National Guard with AH-64s?" does not present a sufficiently specific problem

[2]Conceptually, the issue is no different from the one addressed by balance sheets in calculating the "net change" in resources. Just as it is inappropriate to count personnel savings when a unit deactivates but endstrength stays the same, it is also inappropriate to count costs that do not change the level of total expenditures.

definition for the purpose of cost analysis. First, the full scope of the problem must be established. What kind of Guard unit would be modernized? (The greater the difference between the newly formed AH-64 unit and its predecessor, the greater the cost consequences of the change.) What would be the source of the AH-64 equipment? (Whether the equipment comes from production or from a deactivating unit will have major effects on cost outcomes.) What will become of the equipment displaced by the AH-64s? (Whether that equipment goes into idle capacity or displaces even older equipment in another unit will, likewise, have major effects on cost outcomes.)

In addition, beginning a cost analysis requires the specification of alternatives, since the goal of an analysis is to assess the cost of modernizing the Guard with AH-64s *compared with other force structure alternatives*. Making no changes to the force structure is not a real alternative in this case; the AH-64s are coming off production and must be based somewhere. We chose to compare the cost of modernizing the Guard unit with the cost of modernizing an active unit with the same equipment. Thus the specific issue in this analysis becomes the cost of converting an AH-1 active unit to AH-64s compared with the cost of converting an AH-1 Guard unit to AH-64s.

Table 4.1 examines the two alternative modernizations. Option 1 refers to Guard unit modernization, whereas Option 2 refers to active unit modernization. Completing this table forces the analyst to answer the three questions posed above and clarifies the indirect effect of the primary modernizations. By recording the source and disposition of all major equipment, the table identifies all units affected by the force structure change. It makes clear that for both alternatives the new equipment is coming off the production lines and that an AH-1 unit is being modernized. In addition, it shows that the AH-1 equipment freed up by the modernization replaces UH-1M lift helicopters in another Guard unit. The "domino effect" ends there, however, as the freed UH-1M helicopters become idle.

Although Table 4.1 shows that the full decision space includes two modernizations for each option, the second (modernizing the UH-1M unit with AH-1s) need not be costed to differentiate between the options. The reason is that the second modernization is common to both alternatives, and will thus involve the same cost in both cases. Whereas total costs would be important for budgeting that part of the decision, choosing among alternatives requires only an estimate of incremental costs. Thus, a careful problem definition can help limit the cost analysis problem—an important attribute given the demand for fast response.

Table 4.1

Change in Force Structure: AH-64 Study

Type of Change	Unit Type (Component) Before	After	New Equipment Type	Source	Old Equipment Type	Disposition
			Option 1			
Modernization 1a	AH-1 (ARNG)	AH-64 (ARNG)	UH-60As	Production	AH-1s	Other ARNG units
			AH-64s	Production	UH-1s	Mothball
Modernization 1b	UH-1M (ARNG)	AH-1 (ARNG)	AH-1s	N.C. unit	UH-1Ms	Mothball
			Option 2			
Modernization 2a	AH-1 (USAR)	AH-64 (USAR)	UH-60As	Production	AH-1s	ARNG units, float inventory
			AH-64s	Production	UH-1s	Mothball
Modernization 2b	UH-1M (ARNG)	AH-1 (ARNG)	AH-1s	Active unit	UH-1Ms	Mothball

RESOURCE AND MISSION ANALYSIS

Below are the resource and mission effects of our two options for fielding the AH-64. In the case of active force modernization (Option 2), the process was more constrained because we did not have the benefit of investigating an actual case, but had to rely on available data describing generic units. However, this example does provide a realistic test of the methodology because the situation is not unlike that faced by cost analysts when they are called upon to report findings before collection and consideration of all the data. The challenge is in presenting results with proper qualifications.

Wartime Mission

The mission of the newly formed AH-64 unit is to destroy enemy armor, mechanized, and other forces, using fire and maneuver as an integrated member of the combined arms team. The fact that the unit is nondivisional (not attached to an Army division) and associated with the XVIII Corps indicates that it will fight in deep rather than close operations.

Table 4.2 is designed to highlight potential differences in capability, but not to measure them. Thus information about unit characteristics (component, type of unit, and readiness rating) is communicated using simple plus (+) and minus (–) entries. Since the UH-1M unit is excluded from the cost comparison, as explained above, its changes are listed in the "other" column.

Table 4.2 shows that for the Guard unit modernization, both force structure and readiness change. As will become apparent in the resource analysis that follows, the change in readiness carries with it an associated change in cost. Similarly, Option 2 implies an overall drop in readiness because the AH-1 aircraft are moving from a unit with a C-1 rating to a unit with a C-3 rating.

A difference not recorded in Table 4.2 is that Option 2 attains the AH-64 mission more quickly. In the active unit, the transition can take place in less than a year.[3] The Guard unit, working within the constraints of the full-time civilian jobs of their personnel, would take

[3]Unit members would be sent (for extended periods, if necessary) to formal training schools on a phased basis. Upon completion of skill training for individuals, a 90-day unit training period would take place at Ft. Hood, Texas, concluding with a formal evaluation for unit readiness.

Table 4.2

Change in Mission: AH-64 Study

Mission Category	Target Units: Additions	Target Units: Subtractions	Transfer from/to Other Units	Net Change
Option 1				
ANG AH-64 unit, C-1 readiness	+			+
ANG AH-1 unit, C-3 readiness		–	+	0
ANG UH-1M unit, C-3 readiness			–	–
Option 2				
AF AH-64 unit, C-1 readiness	+			+
AF AH-1 unit, C-1 readiness		–		–
ANG AH-1 unit, C-3 readiness			+	+
ANG UH-1M unit, C-3 readiness			–	–

over twice as long to make the transition.[4] For this mission analysis, the result is a temporary difference in mission capability between the two options.

Peacetime Function

The sole peacetime mission of attack helicopter battalions (active or reserve; AH-1 or AH-64) is unit training. Understanding the flying-hour program that supports unit training requires some background. First, Army units often combine multiple weapon systems, each with its own flying-hour program. Attack helicopter squadrons, for example, include scout helicopters that provide reconnaissance and lift helicopters that move personnel and supplies. Second, units with newer equipment often carry fewer aircraft—the table of equipment (TOE)

[4]To field the Apache, the Army National Guard designed innovative fielding plans that would maximize the amount of transition training that could be accomplished at the home station within normal training periods. The strategy has three basic components or phases, which altogether take over two and a half years to complete. The phases include: (1) cadre training, (2) home station training, and (3) battalion training. In Phase 1, a group of some 40 key, full-time personnel from the Guard unit (including commanders, staff, instructor pilots, and senior enlisted supervisors) are sent to Ft. Hood for a full 90-day training program with an active unit. Upon their return to the home station, the personnel become the training overseers for the remainder of the unit personnel in Phase 2. The year-long home station training phase includes unit fielding and technical training activities in the normal and extended drill unit periods. In Phase 3, the entire unit—all of its personnel and equipment—is deployed to Ft. Hood for 30 days (rather than the 90 days required for active forces), for battalion-level training and an ARTEP (Army Training and Evaluation Program).

of an AH-1 unit calls for 21 attack aircraft, whereas the TOE of an AH-64 calls for only 18. Third, the active Army's flying-hour program is based on the number of aircraft, whereas the Guard assigns hours on the basis of the number of crews. This practice allows the Guard to train a full complement of unit manpower, even if it is short on major equipment, simply by making more intensive use of the aircraft available. This procedure can mislead analysts unfamiliar with differences between Army and Guard practices.

Placing an aviation unit in the reserves rather than the active forces may reduce equipment operation costs because reserve units typically fly at a lower OPTEMPO. In the case of AH-64 battalions, reserve units fly 5 to 10 percent less than active ones, primarily because the latter participate in supplementary unit-readiness exercises. However, the problem in this study is not to compare active vs. Guard costs of AH-64 units, but rather to compare the difference between AH-1 and AH-64 units in the active forces with that same difference in the Guard. Under that scenario, no conventional wisdom applies. In this modernization context, the change in OPTEMPO turns out to have more to do with changes in unit readiness ratings than changes in component.

Table 4.3 calculates and compares the flying-hour implications of modernizing an AH-1 battalion in the Guard and in active forces.[5] To avoid confusing flying hours per aircraft with flying hours per crew, the table shows total hours for each unit.[6] Subtractions in the table all refer to equipment in the old AH-1 unit, whereas additions refer to equipment in the new AH-64 unit. Because neither the AH-1 nor AH-64 battalions have external peacetime functions that could be transferred to other units, there are no entries under the "other units" column.

AH-1 units fly at about the same rate as AH-64 units, so only small changes in total flying-hours result from modernizing an AH-1 unit, regardless of component. In fact, in the active case (Option 2), the fly-

[5]References to the UH-1M unit are omitted (though appropriately footnoted), because the changes would be the same under both options.

[6]For that reason, the reader may want to view this table along with Table 4.6, which shows the levels and changes in major equipment.

Table 4.3

Change[a] in Peacetime Function: AH-64 Study (In flying hours)

Type of Equipment	Target Units		Transfer from/to	
	Additions	Subtractions	Other Units	Net Change
		Option 1		
Attack helicopters				
AH-64	2880			2880
AH-1		–2700		2700
Scout helicopters				
OH-58A	1820	–1690		130
Lift helicopters				
UH-60A	510			510
UH-1		–480		–480
		Option 2		
Attack helicopters				
AH-64	3420			3420
AH-1		–3420		–3420
Scout helicopters				
OH-58C	2210	–2210		0
Lift helicopters				
UH-60A	600			600
UH-1		–600		–600

[a]Changes to the UH-1M unit were ignored because costs would be the same under both options.

ing-hour programs are shown to be identical (Table 4.3).[7] This reflects two changes that cancel each other. The new AH-64 unit will have to train more because the equipment is more complex, but it can fly less because requirements specify fewer aircraft in the unit. In the Guard case (Option 1), flying hours increase 5 to 10 percent for each type of aircraft. Those changes, however, are not a function of the units' placement in the Guard. They occur because of the higher readiness rating of the new Guard AH-64 unit (C-1) as compared with that of the old AH-1 unit (C-3).

Table 4.3 gives only the "steady-state" flying-hour program, omitting details about the build-up to the steady-state level during the transition period. The reason is that the cost of equipment usage during

[7]Although flying hours remain constant, flying-hour *costs* will increase greatly because the equipment in the new units is considerably more expensive to operate than the equipment in the older units (see the discussion on costs later in this section).

the transition is included as part of the nonrecurring training cost, addressed later in this section. However, the function table could easily be converted to show the yearly build-up, by asking for flying hours for each of the transition years. These flying hours would have to reflect not total unit flying hours but the net additions over the operation of the AH-1 unit in place.

Manning

Because in the Army (unlike the Air Force) the same TOE manning requirements apply to both the reserve and active forces, one might expect that the change in manning might be the same under the two options. However, manning cost differences can occur in the Guard option that would not apply in the active option. First, the new and old Guard units could differ in part-time manning percentage. In the case of the unit examined in North Carolina, the percentage of full-time manning (and therefore, the personnel cost) in the unit increased from about 33 percent to about 41 percent as a result of the modernization. Second, Guard units have traditionally been allowed to overman in areas with a surplus of potential recruits, and the extent of overmanning could differ between the new and old units. This phenomenon, too, was found in the North Carolina case; the old unit was manned at 118 percent of its authorized level, the new at 123 percent.

Manning levels can differ (in either a Guard or active modernization) if readiness ratings differ between the new and old units. In this case the AH-64 Guard unit was rated C-1, whereas the Guard AH-1 unit was C-3, manned at 10 percent less than was specified in the TOE (Authorized Level of Organization = 1). As a result, more new manning had to be recruited for the Guard modernization than for the active option. In effect, manning-level differences in the Guard option reflected capability changes as well as force structure changes.

Table 4.4 shows the manpower implications of the alternative modernization plans. (As in Table 4.3, additions under target units refer to the AH-64 unit and subtractions to the AH-1 unit.) Because of the reasons cited above, the table shows that the Guard modernization requires more new personnel than does the active modernization. However, *the net effect for both options is zero,* because both modernization plans called for no change in endstrength levels. Thus, the additional new personnel required in the Guard case were taken from other Guard units which, without the modernization, would have had that much greater manning. This demonstrates why balance sheets

Table 4.4

Change[a] in Manpower: AH-64 Study

Type of Manpower	Target Units: Additions	Target Units: Subtractions	Transfer from/to Other Units	Net Change
		Option 1		
ARNG: full-time				
Officers	3	–2	–1	0
Enlisted	18	–8	–10	0
ARNG: part-time				
Officers	77	–75	–2	0
Enlisted	227	–201	–26	0
Technicians	87	–72	–15	0
		Option 2		
Active				
Officers	71	–71		0
Enlisted	193	–204	11	0

[a]Changes to the UH-1M unit were ignored because costs would be the same under both options.

are required for an accurate calculation of costs. Without a total force resource analysis, one could wrongly conclude that changes in the units directly targeted for change reflect changes in the force as a whole.

Note that manning changes under the two options were expressed simply and at a high level of aggregation. There are two explanations for the appropriateness of the scant detail. First, because the cost implications of the decision will not hinge on manpower changes (i.e., endstrength limits will remain the same in both components), great detail is not required. If, instead of the current decision, the problem had centered on the difference in manning costs between an AH-1 and an AH-64 unit, the small and subtle differences would have required a much more detailed breakdown, probably to the level of individual skill group. Second, the purpose of Table 4.4 was to show only the implications of the modernizations on the number of personnel, so that the change in the recurring costs of manpower could be calculated. More detail would be required if, for example, one wanted to calcul e the cost of training.

Table 4.5 shows what might be done to clarify the movement of personnel in the Guard modernization (Option 1). That table treats the modernized battalion as two separate units, once as an AH-1 unit and again as an AH-64 unit. It also expands the "transfer" column to

show the source of new personnel and the disposition of personnel that are leaving. The top half of the table shows, for example, that not all personnel in the AH-64 unit came from the AH-1 unit. Some transferred in from other units and some (i.e., those in the "net change" column) were recruited. Similarly, the bottom half of the table shows that not everyone in the AH-1 unit stayed through the modernization. Some transferred from other units and some left their occupation. Such data would be useful in computing the nonrecurring training cost of the transition, as well as the costs of processing those personnel leaving the unit or (in the case of technicians) their current employment. The analyst must be careful when costing a modernization to note that the movement of people measured is not the total, but rather an estimate of the turnover that is in excess of normal.

Table 4.5

Change[a] in Manpower for Option 1, Additional Detail: AH-64 Study

Type of Manpower	Target Units: Additions	Target Units: Subtractions	Transfer from/to Other Units: New/Old	Transfer from/to Other Units: Other Units	Net Change
			AH-64 Unit		
ARNG: full-time					
Officer	3		–2	–1	0
Enlisted	18		–6	–11	1
ARNG: part-time					
Officer	77		–70	–6	1
Enlisted	227		–190	–34	3
Technician	87		–70	–15	2
			AH-1 Unit		
ARNG: full-time					
Officer		–2	2		0
Enlisted		–8	6	1	–1
ARNG: part-time					
Officer		–75	70	4	–1
Enlisted		–201	190	8	–3
Technician		–72	70		–2

NOTE: Data that accurately reflect what occurred in the case study were not available for this report. Hypothetical data were inserted to illustrate the methodology.

[a]Changes to the UH-1M unit were ignored because costs would be the same under both options.

Finally, Tables 4.4 and 4.5 simplify the organizational complexity of Guard aviation units (as compared with active units). In the Guard, much unit-level maintenance is completed by an aviation support facility (AVSF), which, although usually located on the same site as the unit, is organizationally separate. The function of the AVSF is not much different from that of the SIMAs that complete some unit-level maintenance for Navy ships. But the organizational structure is unique in that the AVSF personnel are Army technicians from the attack helicopter battalions. For this reason, the technicians are actually employed by the AVSF rather than by the unit, a fact that could confuse analysts unfamiliar with Army organization. The Guard's unique aviation maintenance structure is further described under "Cost Consequences" below.

Equipment

Table 4.6, which shows the disposition of major equipment after the change, also reflects the complexity of Army aviation units when compared with those in the Navy and Air Force. It shows the AH-64s as net additions to the force, since they were coming off production, and the AH-1s as transfers to other units. In Option 2, however, more AH-1s were released than required by the modernized UH-1M unit (because of the difference in readiness ratings), so six of the AH-1s became float aircraft for other units. As for the scout helicopters, Table 4.6 shows that they were simply transferred from the old to the new unit. However, note that the series of these aircraft differed by component—in the active case they were OH-58Cs, whereas in the Guard case they were OH-58As. Finally, the table shows that the lift helicopters of the AH-1 unit were retired, replaced by the more modern UH-60As coming out of production.

The purpose of Table 4.6 is not to compute the procurement cost of the added aircraft; those costs are considered sunk when deciding where to place the new aircraft. Filling out the table serves several other purposes. First, by specifying the exact model designation series (MDS) of the equipment, it allows the proper assignment of cost factors in costing out the options. Second, it helps explain the flying-hour program as presented in the function balance sheet (Table 4.3). Finally, completing the table ensures the analyst that all affected units have been specified in the problem definition. For example, filling out the table might have established that the new attack helicopters were coming from an active unit rather than from production, or that the excess AH-1s released in Option 2 were modernizing yet

Table 4.6

Change[a] in Major Equipment: AH-64 Study

Type of Equipment	Target Units Additions	Target Units Subtractions	Transfer from/to Other Units	Transfer from/to Excess Capacity	Net Change
		Option 1			
Attack helicopters					
AH-64	18				18
AH-1		−15	15		0
Scout helicopters					
OH-58A	13	−13			0
Lift helicopters					
UH-60A	3				3
UH-1		−3		3	0
		Option 2			
Attack helicopters					
AH-64	18				18
AH-1		−21	15	6	0
Scout helicopters					
OH-58C	13	−13			0
Lift helicopters					
UH-60A	3				3
UH-1		−3		3	0

[a]Changes to the UH-1M unit were ignored because costs would be the same under both options.

another unit rather than going into idle capacity. In either case, the discovery would lead the analyst to consider whether the affected units ought to be added to the problem definition.

In addition to changes in major equipment, the modernizations involved purchases of other equipment, changes to equipment, and military construction costs. However, because no cost factors for those changes could be obtained, they are not presented in balance-sheet form. Those topics are discussed under nonrecurring costs.

COST CONSEQUENCES

The cost consequences of an AH-1 to AH-64 modernization are discussed below, divided into recurring and nonrecurring cost categories.[8]

Recurring Costs

Table 4.7 shows the recurring costs of AH-1 and AH-64 attack helicopter squadrons in both the Army and Air National Guard. Calculations are determined at a high level of aggregation (i.e., the only distinction is between personnel-related and equipment-related costs), based on the preceding balance sheets and on cost factors obtained from an unpublished cost model maintained by RAND's Arroyo Center. Several conclusions can be drawn from the results. First, O&S costs for AH-64 units exceed those of AH-1 units by a considerable amount, primarily reflecting the difference in maintenance costs. This difference, on the order of $7 million, may turn out to be considerably higher after the Army completes its revised estimate of Apache maintenance costs. Second, the cost of the Apache battalion in the Guard is about three quarters of the cost of a battalion in the active Army. AH-1 battalions are even less expensive, relatively speaking (a proportion of 0.59), primarily because of the lower readiness rating assumed in this case study for the Guard AH-1 unit.

Table 4.7 suggests that the cost of modernizing the attack helicopter battalion in the active Army is essentially the same as the cost of modernizing a similar unit in the Army National Guard. The difference between AH-64 costs and AH-1 cost is $6.4 million in the active force, compared to $7 million in the Guard. This is true despite the lower readiness rating of the Guard AH-1 unit. One reason for this result is the Guard practice of fully manning underequipped units and using that equipment more intensively to train all personnel. These practices tend to lessen the effects of mission-readiness levels on recurring costs.

Having completed the required resource analysis in the balance sheets above, we can safely apply the results of Table 4.7 to our spe-

[8]The cost calculation for the AH-64 study was impeded by the lack of reliable cost factors to support the computations, by the limited scope of the case study (the force structure change studied was confined to the Guard), and by the differences between the Army and the Army National Guard in how they implement force structure changes and maintain their aircraft. As a result, fewer cost comparisons are possible than in the other case studies, and even these are at a fairly high level of detail.

Table 4.7

Recurring Costs of Attack Helicopter Squadrons, by Component: AH-64 Study (In $ million)

Cost Category	Guard Units AH-64	Guard Units AH-1	Guard Units Difference	Active Units AH-64	Active Units AH-1	Active Units Difference
Personnel-related costs	7.7	6.5	1.2	12.8	12.8	0
Equipment-related costs	10.3	4.5	5.8	12.3	5.7	6.6
Total	18.0	11.0	7.0	25.1	18.5	6.6

cific problem. We disregard the difference in the personnel-related costs (because the problem specification called for holding both Army and ARNG endstrength constant) and concentrate on the equipment-related costs (where we have confirmed that indirect effects on other units are absent). But there, on the second line of the table, the conclusion is similar: the difference in recurring costs between Options 1 and 2 would be less than $1 million per year. Further, this conclusion will very likely hold true even if (as described above) the costs of the Apache are substantially revised, because the change would affect an active and Guard modernization about equally.

An important assumption behind the figures of Table 4.7 is that aircraft maintenance in the Guard and the Army costs about the same. However, the separate maintenance infrastructure and differing maintenance practices in the Guard make this assumption difficult to verify. Whereas active AH-64 units are divided into the traditional unit, intermediate, and depot levels, the Guard has an infrastructure with four levels that cut across those boundaries. At the first level, the part-time unit personnel complete about 10 percent of the unit maintenance during their monthly training periods and annual active duty training. The remaining unit-level maintenance, as well as a large portion of the intermediate maintenance, is completed by an AVSF, the second level of maintenance. The AVSF is typically located at the unit site, uses unit equipment, and employs the unit members as civilian technicians, but organizationally it is separate from the unit. "Heavy" intermediate maintenance and much of the depot maintenance is completed at AVCRADs (aviation classification and repair activity depots), the third level of Guard maintenance. Finally, extensive overhauls and repairs, requiring more advanced equipment, are completed at the same depots used by the active Army.

The Guard maintenance method introduces complexities into the active/reserve costing methodology for two reasons. First, even if separate cost factors for the Guard could be obtained, reporting them would require modifying the current cost-element structure used for the other Services, to accommodate the four levels of maintenance. Second, to avoid double-counting the technicians (who work for the unit in the other Services and in the active Army, but who work for the AVSF in the Guard), analysts would need to understand the unique organizational structure for aviation unit maintenance in the Army National Guard.

For this case study, we assume that Apache maintenance costs in the Army and Guard are about equal. As a result, we conclude from Table 4.7 that, because recurring cost differences in our options are minimal, the cost consequences of modernizing in the Guard versus the active Army will be driven by the nonrecurring transition costs of the change. We turn now to a discussion of those costs.

Nonrecurring Costs

As noted earlier, insufficient information was obtained about nonrecurring costs to make up effective balance sheets. Not only was an updated cost factor manual unavailable, but the transition costs for force structure modernizations are more difficult to compute than are force structure changes that add or subtract whole units. When units are merely altered (and not established or disestablished), the costs of training and equipment can no longer be supported by referring to standard documents such as TOEs. Instead, one would want to know the increment of equipment required to upgrade an AH-1 unit to an AH-64 unit, an amount impossible to determine without knowing how much of the old equipment could be used in the new unit. Similarly, for training, one would not be concerned with the costs of training personnel from scratch, but rather the additional training required to upgrade the skills of existing personnel.

The transition costs of the modernized unit in North Carolina were given as follows: (a) costs of fielding the AH-64, \$7 million[9] (including all training costs to the Guard); (b) unit equipment, \$8.5 million; and

[9]The amount was a maximum for a generic modernization. The National Guard Bureau, Aviation Division, estimated that the actual amount might be 20 percent less. However, this amount does not include the costs incurred by U.S. Army Training and Doctrine Command (TRADOC) schools in the completion of formal training (it includes only the payments to the trainees), and does not include all equipment-related costs while training. (See explanation about training below.)

(c) military construction, $4.3 million.[10] In addition, the Guard had to pay $1.4 million to upgrade its OH-58A scout helicopters because the required later series, the OH-58C, proved unavailable to the unit. Finally, the AVCRAD supporting the Apache unit had to purchase about $8 million in additional electronic support equipment to maintain the more technologically advanced AH-64s.[11]

Given that we did not study a specific active force modernization, a precise determination of the difference in transition costs between the options is not possible. Nonetheless, much was learned from examining the Guard modernization more closely. Transition training costs in the Guard case are somewhat higher than in the active case, but they are spread over a longer time period, reducing their present value. Equipment procurement costs would almost surely be lower for the active modernization, probably about half as much, primarily because the Guard AH-1 unit started out with a lower equipment readiness rating. The equipment upgrade costs would depend on the availability of the OH-58Cs to the active unit. Finally, it is less likely that active force modernization would require the procurement of additional support equipment at intermediate maintenance facilities because (unlike the situation in the Guard) those facilities already support the AH-64.

Even if accurate transition costs were available for both our options, they could not be directly compared in this case, because differing time periods were required to implement modernization in the Guard versus the active Army. In an active unit, transition training takes place in less than a year.[12] The Guard had to modify and lengthen this process to account for the part-time nature of its workforce. As a result, to reach the same C-1 readiness rating as the active unit, the Guard takes over two and a half years to complete transition training and unit evaluation.[13]

When transition periods differ, properly comparing transition costs requires more sophisticated measures of output, such as the calculation of net present value of the differing cost streams. An ad hoc method of dealing with the current case might be to cut off training costs for the Guard case after the first year, and consider the remain-

---

[10]Some of the total construction costs of nearly $8 million were unrelated to the force structure change.

[11]Plans are for that particular AVCRAD to support three AH-64 units, so only one-third of the equipment costs should be allocated to the North Carolina unit.

[12]See footnote 17 in Sec. 2.

[13]See footnote 18 in Sec. 2.

ing unit-personnel and flying-hour costs as the build-up of recurring costs.

Our list of nonrecurring costs does not include certain transition costs for which funds were not appropriated. For example, in designing the training program for the AH-64 modernization in the Guard, planners estimated the cost based on the "on paper" difference between the two units, failing to account for the cost of bringing existing AH-1 personnel up to 100 percent MOS qualification. Because the $400,000 cost of that process was unfunded, those costs are not counted in the decision analysis. There was no net addition of money to accommodate the training. Instead, money was taken from other (unspecified) units to fund the task. And just as the active/reserve methodology does not count savings that do not accrue from a force structure change (e.g., when a unit is deactivated but endstrength is not reduced), it also does not count costs that are not incurred. Instead, these costs should be viewed as a reduction in the capability of the remainder of the force to carry out its mission.

Also not included in the above list of transition costs are some of the front-end costs of designing and implementing a fielding plan for the AH-64s in the Army National Guard. In the current case, the front-end implementation costs are important, because they promise to be much higher in the Guard. The front-end costs are of two types. First, there are the overhead costs of designing the program, primarily incurred by the Aviation Division of the National Guard Bureau. One of the problems that arises in accounting for those costs in the case study design is that they represent joint costs without clear criteria for allocation to specific units. Even the number of units incurring those costs is not clear, because much of the design effort of the AH-64 program may be used for other types of units besides attack helicopter battalions. Another type of front-end cost to the whole Guard AH-64 program was the cost of learning how to best implement the fielding plan. For example, in the North Carolina unit, the first of its kind, planners learned from experience to ensure that aircraft were delivered to the unit sooner than they first thought was required. The fielding plan was changed when pilots in the North Carolina unit were ready to fly aircraft five months before they became available. The result was a deterioration of flight skills, leading to nearly 800 extra retraining flying hours (over $2 million worth). These costs might properly be seen as a learning cost of the whole AH-64 program in the Guard, rather than as a cost attributable to the first unit of its kind. Because of the difficulty of appropriately attributing front-end costs to individual units of a new program, we recommend presenting them separately from other unit costs.

RESULTS

Table 4.8 compares all that is known about the effects of the two options and shows that much remains unresolved. Analysts must often present results before all uncertainties of a problem are resolved. When doing so, they should focus on accurately stating the nature of the decision and on clarifying the assumptions behind any cost numbers quoted. Table 4.8 might be used to support the interim conclusion that the cost consequences appear to depend heavily on the difference in transition costs in modernizing in the Army versus the Army National Guard.

Table 4.8

Comparison of Alternatives: AH-64 Study

Effect	Option 1 Guard Modernization	Option 2 Active Modernization
Force structure change	AH-1 unit modernized with AH-64s	AH-1 unit modernized with AH-64s
Component	Army National Guard	Army
Endstrength	No change	No change
Mission readiness	C-3 to C-1 2–3 years to mission readiness	C-1 maintained 1 year to mission readiness
OPTEMPO	Increased 5 to 10%	No change
Increase in recurring costs	$5.8 M	$6.6 M
Transition costs	Greater than $24 M	Probably less than in Guard
Front-end design costs	Yes	No

5. CONCLUSIONS

The case studies examined in this report serve multiple purposes. First, they validate the active/reserve costing methodology, demonstrating both its value (the common problems that it enables cost analysts to overcome) and its range (the wide variety of force structure problems to which it can be applied). Second, the cases extend that methodology in several ways: expanding the meaning of certain terms, applying established techniques to new situations, and developing new tools to increase the method's power. Third, the cases provide a primer for analysts interested in applying the methodology to their own work. Finally, all three studies demonstrate the need for future research related to both the methodology itself and the broader problems of force structure cost analysis.

VALIDATING THE METHODOLOGY

The cases have validated the active/reserve costing methodology on two levels: by illustrating its broad advantages across a wide range of practical cases, and by demonstrating its power to cope with a number of more specific problems.

The methodology offers several fundamental advantages that the case studies serve to illustrate. First, the methodology fosters full problem definition. By forcing one to ask where resources come from and where they go, it assists analysts in uncovering all units and parts of the force affected by the change. Uncovering indirectly affected units proved particularly important in the FF-1052 case studied here in differentiating the study options. Second, the methodology helps the analyst to rise above the unit context of most force structure problems, to properly calculate the *net forcewide* effects of a change. Thus, when the AH-64 modernization required an increase in personnel for that unit but involved no increase in endstrength levels, the net effect was correctly recorded as zero. Third, by showing the details of the calculations of the net effect, the balance sheets foster accuracy and proper documentation. This proved particularly important in the complex case of the C-5 transfer, which involved a large number of units and bases. Finally, the methodology supports the decisionmaking process by highlighting tradeoffs between cost and capability. This feature was particularly helpful in the FF-1052 case, which required the comparison of a large number of alternatives with largely different capability implications.

The three case studies also demonstrate that the methodology performs effectively in a wide variety of practical contexts. All three cases are based on authentic and current active/reserve scenarios—two on actual proposals that arose in the programming cycle of the PPBS process. They cover the three major Services and many different force structure changes: activations, deactivations, modernizations, augmentations, and reductions in major equipment. They raise a wide range of cost-related issues and complexities that occur within force structure change proposals. For example:

- Active/reserve force structure changes are often mixed with other cost-cutting measures. In the FF-1052 case, for example, a transfer of ships to the reserves was combined with an independent proposal to change maintenance procedures for reserve ships. By isolating the effects of the different strategies and presenting their cost consequences separately, the methodology allowed separate decisions on separate issues.
- In practice, some expenditures incurred as a result of a force structure change do not receive funding. This occurred in the AH-64 modernization, in which some of the transition costs had to be funded out of the existing budget. The active/reserve force structure methodology treats such costs, not as an additional expenditure, but as a reallocation of resources—toward the AH-64 unit and away from other units in the force. Such changes are important to record because they affect the relative capability of different types of force structure units.
- Some cost estimates are inherently more reliable than others. In the FF-1052 case, the stability of estimates of recurring cost savings proved to vary considerably across options. As a result, a proper comparison of options required that the methodology include information about the variance of the cost estimates in the presentation of results.
- The allocation of joint costs can become particularly problematic when a basis for allocation is absent. In the AH-64 case, there were substantial front-end costs (because the mission was new to the Guard) to designing and implementing the fielding program. It would be improper to allocate all those costs to the units under study in this report, because there were (an uncertain number of) other AH-64 modernizations to follow. In this case, we ended up dealing with such expenses by presenting them separately from other decision costs.
- Options can be more difficult to compare when the lengths of their transition periods differ. In the AH-64 case, the modern-

ization of the active AH-1 unit could occur within a year; however, because the Guard had to deal with the part-time nature of its workforce, the modernization would take over two years. Under such circumstances, a simple comparison of recurring and nonrecurring costs between the two options is not valid, and instead requires a more sophisticated cost measurement (e.g., computation of net present values).

EXTENDING THE METHODOLOGY

The case studies not only validate the methodology as defined in prior documents, but also extend or enrich it in three important ways. We briefly mention these ways below, and invite the reader to refer to the conclusions and results subsections of Secs. 2–4 for further elaboration on individual points.

1. Expanding the definition of important terms. The report instructs the analyst on choosing appropriate, detailed descriptors of mission, function, manpower, equipment, and basing, the basic categories of unit change. The meaning and use of terms like "other units" and "excess capacity," which are vital to the calculation of net resource effects, are clarified. The report describes the presentation of cost results, placing them in the larger context of changes in inputs and outputs. Finally, case study results add to the list of costs that can occasionally arise under the "other recurring" and "other nonrecurring" cost categories in the cost model.

2. Addressing new methodological issues. Each case raised several important methodological issues and demonstrated how the methodology could be extended to deal with them. For example, the report shows (a) how to modify the cost-element structure to accommodate aviation units in the Army National Guard, (b) how to capture changes in support organizations (e.g., those that provide higher level maintenance or acquisition and training services), (c) how to register the savings in equipment and facilities due to the collocation of similar units on the same base, and (d) how to register changes to individual units in a multiple-unit problem.

3. Creating new methodological tools. The cases extend the methodology by offering new analytic tools. For example, because the C-5 study involved complex force structure changes, a new tool was required to adequately describe the change. Three tables spelled out the nature of the force structure changes in this case: one showed the baseline configuration of C-5 units, another showed the proposed configuration after the change under each of the options, and a third

showed how the proposed changes would be accomplished. These new formats enrich the methodology; they can help clarify decisions, highlight significant cost-driving factors at an early stage of analysis, and provide input for describing changes to wartime mission.

The FF-1052 case extended the methodology by creating a new worksheet and reference tool (Table 3.1) designed to facilitate analysis of a large number of options. This format offers a nonquantitative brief summary of the effects of force structure changes. Like the balance sheets, it distinguishes between "target" and "other" units, and asks for changes according to the five basic components of unit change (mission, function, manpower, equipment, and basing). Unlike the balance sheets, it requires no detailed change categories or precise data, leaving the researcher free to concentrate on the direction of major effects. This tool should aid the process of formulating problems and designing alternatives, and should provide a guide for completing the more detailed balance sheets.

APPLYING THE METHODOLOGY

This report goes beyond demonstration to issues of application. Each of the studies covers a wide range of issues and carries a unique emphasis, but the issues are not exhaustive; a different set of cases would raise different issues and require different adaptations. Although the methodology appears flexible enough to handle new situations, judgment is required. In applying the method to their own work, analysts will have to decide how to apply the method and sometimes even how to modify its standard tools. One purpose of these cases, then, is to help analysts develop that judgment. By carefully explaining the reasoning behind methodological changes, the report acts as a primer on how to think about active/reserve force-mix problems. Thus, although analysts will surely come across methodological problems that are not specifically addressed in these cases, a careful reading of this report should better equip them to design the appropriate modifications or extensions.

FUTURE RESEARCH

For cost analysts involved in the programming and budgeting phases of the defense budget, there are a number of ways in which the methodology might be usefully enhanced. Some involve improvements in the methodology itself; another requires enhancements to one of the method's most important inputs.

Improvements to the Active/Reserve Methodology

- Balance sheets and cost tables might be converted to a fully dynamic system, so that costs and resources could be accounted for on a year-by-year basis. The time variable is now reflected in the methodology only in the division of costs into recurring and nonrecurring categories.
- The methodology might offer guidance in mapping the cost elements of the active/reserve costing methodology into the appropriation categories of the federal budget. Any formal proposal that would change the defense budget would have to express changes both over time and in terms of appropriation categories.
- Additional research might incorporate what the model considers to be fixed overhead elements. Something closer to a total force model could more precisely estimate the costs of large changes in force structure. Currently, the methodology applies to only relatively small changes in force structure.
- The cost analyst's task would be greatly facilitated by automating the methodology. Computerization would improve the speed and accuracy of the cost analysis, could be programmed to automatically calculate summary measure of results (e.g., net present values and break-even points), and could provide an easy method of documenting results. Forthcoming RAND reports will examine automation more thoroughly.
- The methodology would improve with the completion of additional case studies involving other types of units and weapon systems. In this report, the study of an aviation unit in the Army National Guard added to our understanding of maintenance practices and allowed us to modify the model's cost-element structure. In future case studies, we believe that improving the understanding of the nonrecurring transition costs of force structure change should be emphasized.
- Finally, the active/reserve cost methodology could better serve intended users if its principles and use were set down in the form of a cost manual, prepared as a step-by-step application guide.

Improving Inputs: The Need for Cost Factors

In addition to improvements in the methodology itself, the tool described in this report would benefit greatly from improved cost factors that serve as its input. Obtaining reliable cost factors for two of the

three studies proved difficult, in part requiring that we create our own factors, a time-consuming and imprecise process.

In addition, all three case studies strongly suggest that the relative difficulty of obtaining nonrecurring transition cost factors leads to imbalances in force structure decisionmaking, especially in the context of budget-cutting drills. In those instances, proposed options typically compare potential operational savings with front-end transition costs. Clearly, knowing only half of the equation does not allow for optimum choice. Thus, in the C-5 case, the difficulty of calculating transition costs led to the detailed consideration of an alternative that should have been screened out at a much earlier stage. And in the FF-1052 case, an alternative was chosen based on the undocumented assumption that transition costs would be zero.